Deep Inelastic Scattering 2025

Report of Contributions

https://indico.cern.ch/e/1436959

Contribution ID: **1** Type: **not specified**

Strong Coupling from Inclusive Semi-leptonic Decay of Charmed Mesons

Employing the heavy quark expansion model with the kinetic scheme, we evaluate $\alpha_S(m_c^2)$, the strong coupling constant at the charm quark mass m_c with data on inclusive semileptonic decays of charmed mesons. Using the experimental values of semileptonic decay widths of the D^0 and the D^+, the value of $\alpha_s(m_c^2)$ is determined to be $0.445 \pm 0.009 \pm 0.114$, where the first uncertainty is experimental and the second systematic. This reported $\alpha_s(m_c^2)$ is in good agreement with the value of $\alpha_s(m_c^2)$ calculated by running $\alpha_S(m_Z^2)$ at the Z^0 boson mass m_Z with the renormalization group evolution equation. In addition, values of $\alpha_s(m_c^2)$ obtained individually from each of the D^0, D^+, and D_s^+ mesons are found to be consistent being of the same origin. The outcome of this work determined the α_s at $m_c = 1.37$GeV, which is the first measurement of this quantity below the τ mass. The measurement represents a new approach to determine $\alpha_s(m_c^2)$, and indicates that an important feature of Quantum Chromo-Dynamics, asymptotic freedom, is still valid at the energy scale of charm quark mass. This measurement can help to further understand strong interaction, and probe possible new physics.

Author: WU, Jinfei (Institute of High Energy Physics, CAS)

Co-authors: Prof. LI, Gang (Institute of High Energy Physics, CAS); Prof. YE, Jingbo (Institute of High Energy Physics, CAS); Prof. RUAN, Manqi (Institute of High Energy Physics, CAS); Prof. LOU, Xinchou (Institute of High Energy Physics, CAS); Prof. HUANG, Yanping (Institute of High Energy Physics, CAS); Mr CHE, Yuzhi (Institute of High Energy Physics, CAS)

Presenter: WU, Jinfei (Institute of High Energy Physics, CAS)

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **3** Type: **not specified**

Prospects for Measurements of the longitudinal proton structure function FL at the EIC

Tuesday 25 March 2025 17:00 (20 minutes)

We explore the potential for extracting the longitudinal proton structure function FL(x, Q2) at the future Electron-Ion Collider (EIC) through a Rosenbluth separation method. The impacts of differing assumptions on systematic uncertainties and beam energy scenarios are investigated. With a sufficiently large number of centre of mass energy configurations, the EIC will measure FL with an unprecedented precision and will access a kinematic range that complements both fixed target and HERA data. In the most optimistic scenarios, the EIC data will be a highly competitive direct probe of the proton gluon density.

Authors: JIMENEZ LOPEZ, Javier (Universidad de Alcala, Madrid, Spain); WICHMANN, Katarzyna (Deutsches Elektronen-Synchrotron (DE)); NEWMAN, Paul Richard (University of Birmingham (GB))

Presenter: WICHMANN, Katarzyna (Deutsches Elektronen-Synchrotron (DE))

Session Classification: WG1/6: Joint session (WG1/6: Structure Functions and Parton Densities + Future Experiment)

Track Classification: Structure Functions and Parton Densities

Contribution ID: **4** Type: **not specified**

Entanglement as a probe of hadronization

Tuesday 25 March 2025 14:22 (20 minutes)

In this talk, we present our extension of the concept of maximal quantum entanglement from proton structure to jet fragmentation in proton-proton collisions, establishing a connection between jet fragmentation functions and charged hadron multiplicity [1]. This relationship is tested using ATLAS data from the Large Hadron Collider, showing excellent agreement. As the first study to apply quantum entanglement concepts to hadronization within jets, our results provide new insights into the quantum aspects of hadronization and the transition between perturbative and non-perturbative QCD, deepening our understanding of confined nuclear matter.

[1] J. Datta, A. Deshpande, D. E. Kharzeev, **C. J. Naïm**, and Z. Tu, "Entanglement as a probe of hadronization,"arXiv, no. 2410.22331, Oct. 2024.

Author: NAIM, Charles Joseph

Presenter: NAIM, Charles Joseph

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **5** Type: **not specified**

Measurements of electroweak penguin and lepton-flavour violating B decays at Belle and Belle II

Wednesday 26 March 2025 10:00 (20 minutes)

The Belle and Belle II experiments have collected a 1.1 ab^{-1} sample of $e^+e^- \to B\bar{B}$ collisions at a centre-of-mass energy corresponding to the $\Upsilon(4S)$ resonance. These data, with low particle multiplicity and constrained initial state kinematics, are an ideal environment to search for rare electroweak penguin B decays and lepton-flavour violating decays to final states with missing energy from neutrinos. Results include those of the decay $B \to K^+\nu\bar{\nu}$ using an inclusive tagging technique. In addition, we present searches for the SM processes $B \to K^{(*)}\tau^+\tau^-$. In addition, we present radiative B decay results. Finally, our search for the lepton-flavour violating decay $B^0 \to K^0_S\tau^+\ell^-$, where ℓ is an electron or muon, is described.

Authors: ROBERTSON, Steven (IPP / University of Alberta); KWON, Youngjoon

Presenter: KWON, Youngjoon

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **6** Type: **not specified**

Studies of hadron spectroscopy at Belle and Belle II

Wednesday 26 March 2025 11:44 (20 minutes)

The Belle and Belle II experiments have collected a $1.4\ \mathrm{ab}^{-1}$ sample of e^+e^- collision data at centre-of-mass energies near the $\Upsilon(nS)$ resonances. These data include a 19.2 fb^{-1} sample of data collected at centre-of-mass energies near the $\Upsilon(10753)$ resonance. We present several results related to the following processes: $e^+e- \to \Upsilon(nS)\eta$, $e^+e- \to \gamma X_b(\chi_{bJ}\pi^+\pi^-)$, $e^+e^- \to h_b(1P)\eta$ and $e^+e^- \to \chi_{bJ}(1P)\omega$. The last analysis also includes data samples collected by Belle at similar centre-of-mass energies. In addition, we present Belle measurements of the B^0 and B^+ meson mass difference, a pentaquark search in $\Upsilon(1S)$ and $\Upsilon(2S)$ decays, as well as studies of $h_b(2P)$ decays to the $\eta\Upsilon(1S)$ and $\chi_{bJ}\gamma$ final states.

Author: KWON, Youngjoon

Presenter: KWON, Youngjoon

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **7** Type: **not specified**

ATLAS Upgrades for the High Luminosity LHC

Tuesday 25 March 2025 09:00 (22 minutes)

While the on-going Run-3 data-taking campaign will provide twice the integrated proton-proton luminosity currently available at the LHC, most of the data expected for the full LHC physics program will only be delivered during the HL-LHC phase. For this, the LHC will undergo an ambitious upgrade program to be able to deliver an instantaneous luminosity of 7.5×10^{34} cm^{-2} s^{-1}, allowing the collection of more than 3 ab^{-1} of data at $\sqrt{s}$ =13.6 (14) TeV. This unprecedented data sample will allow ATLAS to perform several precision measurements to constrain the Standard Model Theory (SM) in yet unexplored phase-spaces, in particular in the Higgs sector, a phase-space only accessible at the LHC. To benefit from such a rich data-sample it is fundamental to upgrade the detector to cope with the challenging experimental conditions that include huge levels of radiation and pile-up events. The ATLAS upgrade comprises a completely new all-silicon tracker with extended rapidity coverage that will replace the current inner tracker detector; a redesigned trigger and data acquisition system for the calorimeters and muon systems allowing the implementation
of a free-running readout system. Finally, a new subsystem called High Granularity Timing Detector will aid the track-vertex association in the forward region by incorporating timing information into the reconstructed tracks. An important ingredient, relevant to almost all measurements, is a precise determination of the delivered luminosity with systematic uncertainties below the percent level. This challenging task will be achieved by collecting the information from several detector systems using different and complementary techniques.
This presentation will describe the ongoing ATLAS detector upgrade status and the main results obtained with the prototypes, giving a synthetic, yet global, view of the whole upgrade project.

Author: MCKENZIE, Ryan Peter (University of the Witwatersrand (ZA))

Presenter: MCKENZIE, Ryan Peter (University of the Witwatersrand (ZA))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **8** Type: **not specified**

QCD effects in inclusive B-meson decays

A recently completed calculation of next-to-next-to-leading QCD corrections to the weak radiative B-meson decay is going to be reported. Contrary to previous estimates of these corrections, no interpolation in the charm quark mass is necessary. Next, the current status of determining perturbative and non-perturbative contributions to the inclusive semileptonic B-meson decays is going to be discussed.

Author: MISIAK, Mikolaj Krzysztof (University of Warsaw (PL))

Presenter: MISIAK, Mikolaj Krzysztof (University of Warsaw (PL))

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **9** Type: **not specified**

Overview on Efforts for a Second Detector at the Electron-Ion Collider (EIC)

Wednesday 26 March 2025 16:22 (22 minutes)

The Electron-Ion Collider (EIC) will provide a unique experimental platform to explore the properties of gluons in nucleons and nuclei, offering new insights into their structure and dynamics. The EIC community has outlined a detailed physics program in the White Paper and identified the demanding detector requirements in the Yellow Report. The primary general-purpose detector, ePIC, is designed to support a broad range of physics studies. However, there is strong community support for a second detector at the EIC to further enhance the scientific capabilities of the facility. A second detector would provide cross-checks and systematic controls for potential discoveries, while incorporating complementary technologies to address physics measurements that may be underrepresented by ePIC. In particular, it would improve forward detector acceptance at low transverse momentum (p_T) and enable more precise measurements in exclusive, diffractive, and tagging physics. This talk will provide a general overview of the second detector and outline its potential capabilities, highlighting key areas of the physics program it could enhance.

Author: KIM, Jihee

Presenter: KIM, Jihee

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **10** Type: **not specified**

Proton Parton Densities from Deep Inelastic Scattering Only - From the Current to the Ultimate Picture

Tuesday 25 March 2025 16:00 (20 minutes)

The HERAPDF2.0 parton densities represent the current state of the art in determining the longitudinal structure of the proton using data from Deep Inelastic Scattering (DIS) experiments alone. Their precision is at the few percent level at intermediate Bjorken-x, but deteriorates fast for x−>1 and also below x˜10ˆ-3. The high x region in particular can also be constrained using LHC data, though at the price of increased theoretical complexity and currently with tensions between data sets. In this study we investigate how the picture may evolve with time in the future by using only DIS ingredients in proton PDF fits. We start by including simulated data from the Electron Ion Collider (EIC), which are known to improve matters at large x. We then additionally add simulated data from the Large Hadron electron Collider (LEeC), the Future Circular Collider (FCC) in ep mode, or both. The LHeC is shown to potentially revolutionise the precision at both large and small x, even with EIC data are included. In the longer term the FCC-eh may allow further progress at low x, extending the sensitivity toward x=10-7. We also study the results of leaving the strong coupling as a free parameter in the fits. Once again, the LHeC and/or FCC-eh yield significant improvements even beyond the currently world-leading potential of an EIC determination.

Authors: WICHMANN, Katarzyna (Deutsches Elektronen-Synchrotron (DE)); NEWMAN, Paul Richard (University of Birmingham (GB))

Presenter: WICHMANN, Katarzyna (Deutsches Elektronen-Synchrotron (DE))

Session Classification: WG1/6: Joint session (WG1/6: Structure Functions and Parton Densities + Future Experiment)

Track Classification: Structure Functions and Parton Densities

Contribution ID: **11** Type: **not specified**

Observation and differential cross section measurement of neutral current DIS events with an empty hemisphere in the Breit frame

The Breit frame provides a natural frame to analyze lepton–proton scattering events. In this reference frame, the parton model hard interactions between a quark and an exchanged boson defines the coordinate system such that the struck quark is back-scattered along the virtual photon momentum direction. In Quantum Chromodynamics (QCD), higher order perturbative or non-perturbative effects can change this picture drastically. As Bjorken-x decreases below one half, a rather peculiar event signature is predicted with increasing probability, where no radiation is present in one of the two Breit-frame hemispheres and all emissions are to be found in the other hemisphere. At higher orders in α_s or in the presence of soft QCD effects, predictions of the rate of these events are far from trivial, and that motivates measurements with real data. We report on the first observation of the empty current hemisphere events in electron–proton collisions at the HERA collider using data recorded with the H1 detector at a center-of-mass energy of 319 GeV. The fraction of inclusive neutral-current DIS events with an empty hemisphere is found to be $0.0112 \pm 3.9\%_{\text{stat}} \pm 4.5\%_{\text{syst}} \pm 1.6\%_{\text{mod}}$ in the selected kinematic region of $150 < Q^2 < 1500$ GeV^2 and inelasticity $0.14 < y < 0.7$. The data sample corresponds to an integrated luminosity of 351.1 pb^{-1}, sufficient to enable differential cross section measurements of these events. The results show an enhanced discriminating power at lower Bjorken-x among different Monte Carlo event generator predictions.

Eur.Phys.J.C84 (2024), 720 [arxiv:2403.08982]

Authors: BRITZGER, Daniel (Max-Planck-Institut für Physik München); COLLABORATION, H1 (DESY); SCHMITT, Stefan (Deutsches Elektronen-Synchrotron (DE)); ZHANG, Zhiqing Philippe (IJCLab, Orsay (FR))

Presenter: COLLABORATION, H1 (DESY)

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **12** Type: **not specified**

Measurement of the 1-jettiness event shape observable in deep-inelastic electron-proton scattering at HERA

Wednesday 26 March 2025 14:00 (20 minutes)

The H1 Collaboration reports the first measurement of the 1-jettiness event shape observable τ_1^b in neutral-current deep-inelastic electron-proton scattering (DIS). The observable τ_1^b is equivalent to a thrust observable defined in the Breit frame. The data sample was collected at the HERA ep collider in the years 2003–2007 with center-of-mass energy of $\sqrt{s} = 319$ GeV, corresponding to an integrated luminosity of 351.1 pb^{-1}. Triple differential cross sections are provided as a function of τ_1^b, event virtuality Q^2, and inelasticity y, in the kinematic region $Q^2 > 150$ GeV^2. Single differential cross section are provided as a function of τ_1^b in a limited kinematic range. Double differential cross sections are measured, in contrast, integrated over τ_1^b and represent the inclusive neutral-current DIS cross section measured as a function of Q^2 and y. The data are compared to a variety of predictions and include classical and modern Monte Carlo event generators, predictions in fixed-order perturbative QCD where calculations up to $\mathcal{O}(\alpha_s^3)$ are available for τ_1^b or inclusive DIS, and resummed predictions at next-to-leading logarithmic accuracy matched to fixed order predictions at $\mathcal{O}(\alpha_s^2)$. These comparisons reveal sensitivity of the 1-jettiness observable to QCD parton shower and resummation effects, as well as the modeling of hadronization and fragmentation. Within their range of validity, the fixed-order predictions provide a good description of the data. Monte Carlo event generators are predictive over the full measured range and hence their underlying models and parameters can be constrained by comparing to the presented data.

Eur.Phys.J.C 84 (2024), 785 [arxiv:2403.10109]

Author: Dr TU, Zhoudunming (BNL)

Presenter: Dr TU, Zhoudunming (BNL)

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **13** Type: **not specified**

Measurement of groomed event shape observables in deep-inelastic electron-proton scattering at HERA + Observation and differential cross section measurement of neutral current DIS events with an empty hemisphere in the Breit frame

Wednesday 26 March 2025 14:22 (20 minutes)

The H1 Collaboration at HERA reports the first measurement of groomed event shape observables in deep inelastic electron-proton scattering (DIS) at $\sqrt{s} = 319$ GeV, using data recorded between the years 2003 and 2007 with an integrated luminosity of 351 pb^{-1}. Event shapes provide incisive probes of perturbative and non-perturbative QCD. Grooming techniques have been used for jet measurements in hadronic collisions; this paper presents the first application of grooming to DIS data. The analysis is carried out in the Breit frame, utilizing the novel Centauro jet clustering algorithm that is designed for DIS event topologies. Events are required to have squared momentum-transfer $Q^2 > 150$ GeV^2 and inelasticity $0.2 < y < 0.7$. We report measurements of the production cross section of groomed event 1-jettiness and groomed invariant mass for several choices of grooming parameter. Monte Carlo model calculations and analytic calculations based on Soft Collinear Effective Theory are compared to the measurements

Eur.Phys.J.C84 (2024), 718 [arxiv:2403.10134]

The Breit frame provides a natural frame to analyze lepton–proton scattering events. In this reference frame, the parton model hard interactions between a quark and an exchanged boson defines the coordinate system such that the struck quark is back-scattered along the virtual photon momentum direction. In Quantum Chromodynamics (QCD), higher order perturbative or non-perturbative effects can change this picture drastically. As Bjorken-x decreases below one half, a rather peculiar event signature is predicted with increasing probability, where no radiation is present in one of the two Breit-frame hemispheres and all emissions are to be found in the other hemisphere. At higher orders in α_s or in the presence of soft QCD effects, predictions of the rate of these events are far from trivial, and that motivates measurements with real data. We report on the first observation of the empty current hemisphere events in electron–proton collisions at the HERA collider using data recorded with the H1 detector at a center-of-mass energy of 319 GeV. The fraction of inclusive neutral-current DIS events with an empty hemisphere is found to be $0.0112 \pm 3.9\%_{\text{stat}} \pm 4.5\%_{\text{syst}} \pm 1.6\%_{\text{mod}}$ in the selected kinematic region of $150 < Q^2 < 1500$ GeV^2 and inelasticity $0.14 < y < 0.7$. The data sample corresponds to an integrated luminosity of 351.1 pb^{-1}, sufficient to enable differential cross section measurements of these events. The results show an enhanced discriminating power at lower Bjorken-x among different Monte Carlo event generator predictions.

Eur.Phys.J.C84 (2024), 720 [arxiv:2403.08982]

Authors: ARRATIA, Miguel; ARRATIA MUNOZ, Miguel

Presenters: ARRATIA, Miguel; ARRATIA MUNOZ, Miguel

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **14** Type: **not specified**

Machine Learning-Assisted Measurement of Lepton-Jet Azimuthal Angular Asymmetries in Deep-Inelastic Scattering at HERA + Deep learning full phase-space measurement of high Q^2 ep collisions at HERA

Tuesday 25 March 2025 09:44 (20 minutes)

In deep-inelastic positron-proton scattering, the lepton-jet azimuthal angular asymmetry is measured using data collected with the H1 detector at HERA. When the average transverse momentum of the lepton-jet system,
$lvert\vec{P}_\perp$
$rvert$, is much larger than the total transverse momentum of the system,
$lvert\vec{q}_\perp$
$rvert$, the asymmetry between parallel and antiparallel configurations, $\vec{P}_\perp$ and $\vec{q}_\perp$, is expected to be generated by initial and final state soft gluon radiation and can be predicted using perturbation theory. Quantifying the angular properties of the asymmetry therefore provides an additional test of the strong force. Studying the asymmetry is important for future measurements of intrinsic asymmetries generated by the proton's constituents through Transverse Momentum Dependent (TMD) Parton Distribution Functions (PDFs), where this asymmetry constitutes a dominant background. Moments of the azimuthal asymmetries are measured using a machine learning method for unfolding that does not require binning.

Using modern machine learning, a measurement of all outgoing particles from high Q^2 electron-proton collisions is presented using data recorded with the H1 detector at HERA. The resulting differential cross section is unbinned and multi-dimensional, yet unfolded to the particle level. It thus allows for flexible reinterpretations.

Authors: ARRATIA, Miguel; ARRATIA MUNOZ, Miguel

Presenters: ARRATIA, Miguel; ARRATIA MUNOZ, Miguel

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **15** Type: **not specified**

Studies of N3LO Fits to DIS Data Using xFitter

Tuesday 25 March 2025 14:00 (22 minutes)

We investigate the impact of recently computed N3LO corrections to QCD splitting and DIS coefficient functions on global fits of parton distribution functions (PDFs) using the xFitter framework. By comparing fits performed at different perturbative orders, we analyze the modifications introduced to PDFs and their associated uncertainties, incorporating correlated experimental errors. Additionally, the effects of various approximations for splitting functions are assessed, providing a basis for estimating theoretical uncertainties. The results show the importance of the N3LO corrections and the need for further theoretical refinement in the low-x regime.

Author: XFITTER, Developer

Co-author: GLAZOV, Alexander (Deutsches Elektronen-Synchrotron (DE))

Presenter: GLAZOV, Alexander (Deutsches Elektronen-Synchrotron (DE))

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **17** Type: **not specified**

Approximate N3LO PDFs: Updates and Consequences for Phenomenology

Tuesday 25 March 2025 14:22 (22 minutes)

We will discuss several key updates to the MSHT approximate N3LO PDFs; including the combination of these aN3LO QCD PDFs with QED effects, the first determination of the strong coupling constant at aN3LO, and further updates based on new theoretical information available at N3LO including more precise splitting functions for N3LO PDF evolution. All of this work has important consequences for phenomenology in a variety of physics analyses at the LHC currently being undertaken. We will review a selection of these, including consequences for Higgs production in gluon fusion, vector boson fusion Higgs production, Drell-Yan production and others.

Author: CRIDGE, Thomas (DESY)

Presenter: CRIDGE, Thomas (DESY)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **18** Type: **not specified**

Theoretical Uncertainties on the determination of the strong coupling from Z pT

Wednesday 26 March 2025 11:22 (22 minutes)

I will analyse the theoretical uncertainties inherent in the determination of the strong coupling from the transverse momentum (pT) spectrum of the Z boson. Such analyses require fine control of percent-level theoretical effects in small pT region, not only in terms of their magnitude but also of their shape and that of the corresponding theoretical uncertainties. This is theoretically extremely challenging. In this talk I will analyse the associated theoretical uncertainties via the novel theoretical nuisance parameter approach. In particular, I will focus on the perturbative uncertainty from missing higher orders in resummation, the uncertainty related to the nonperturbative model, and that associated with the parton distribution functions.

Author: CRIDGE, Thomas (DESY)

Presenter: CRIDGE, Thomas (DESY)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **19** Type: **not specified**

ATLAS tt+HF measurements including tt+bb

Tuesday 25 March 2025 09:00 (20 minutes)

The top-quark pair production in association with heavy-flavour jets (b/c) is a difficult process to calculate and model and is one of the leading sources of background to ttH and 4tops in 1l/2LOS channel. To improve our understanding of this process, a new inclusive and differential measurement of this process was performed.

Author: GOLLING, Tobias (Universite de Geneve (CH))

Presenter: GOLLING, Tobias (Universite de Geneve (CH))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **20** Type: **not specified**

Overview of EFT-based searches involving top quarks at ATLAS

Tuesday 25 March 2025 09:20 (20 minutes)

Many-parameter fits to precise measurements in the framework of the Standard Model Effective Field Theory are becoming a standard interpretation of LHC and other collider data. In this contribution an overview is given of state-of-the-art EFT interpretations in ATLAS with particular emphasis on results in the top quark sector.

Author: CHITISHVILI, Mariam (Instituto de Física Corpuscular (IFIC))

Presenter: CHITISHVILI, Mariam (Instituto de Física Corpuscular (IFIC))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **21** Type: **not specified**

Highlights on top quark properties and mass measurements with the ATLAS detector

Tuesday 25 March 2025 11:00 (20 minutes)

The top-quark mass is one of the key fundamental parameters of the Standard Model that must be determined experimentally. Its value has an important effect on many precision measurements and tests of the Standard Model. The Tevatron and LHC experiments have developed an extensive program to determine the top quark mass using a variety of methods. In this contribution, the top quark mass measurements by the ATLAS experiment are reviewed. These include measurements in two broad categories, the direct measurements, where the mass is determined from a comparison with Monte Carlo templates, and determinations that compare differential cross-section measurements to first-principle calculations. In addition, new results on top-quark properties are shown. This includes the first observation of quantum entanglement in top-quark pair events and tests of lepton-flavour universality.

Author: MALITO, Davide (Royal Holloway, University of London (GB))

Presenter: MALITO, Davide (Royal Holloway, University of London (GB))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **22** Type: **not specified**

Jet substructure measurements with the ATLAS experiment

Thursday 27 March 2025 10:06 (20 minutes)

Jets, the collimated streams of hadrons resulting from the fragmentation of highly energetic quarks and gluons, are some of the most commonly observed radiation patterns in hadron collider experiments. The distribution of quantum chromodynamic (QCD) radiation within jets is determined by complex processes, the production of showers of quarks and gluons and their subsequent recombination into hadrons. In this talk, two recent measurements of the jet substructure from the ATLAS experiment are presented. The measurements utilise either multijet events or jets produced in the decay of W bosons and the fragmentation of b-quarks in top pair production, using the reconstructed charged particles inside the jet. Presented are measurements of non-perturbative track functions, as well as differential cross-section of Lund sub-jet multiplicities and measurements of the Lund Jet Plane in top quark pair production. The results are compared to a large variety of parton shower models and tunes.

Author: CAMPANELLI, Mario (UCL)

Presenter: CAMPANELLI, Mario (UCL)

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **23** Type: **not specified**

Measurements of jet cross-section ratios with ATLAS

Thursday 27 March 2025 09:22 (20 minutes)

Jet cross-section ratios between inclusive bins of jet multiplicity are measured differentially in variables that are sensitive to either the energy-scale or angular distribution of hadronic energy flow in the final state. Several improvements to the calibration of jets are described, which result in significant improvements in the overall jet energy scale uncertainty. The measurements are compared to state-of-the-art NLO and NNLO predictions, and used to determine the strong-coupling constant at the reference scale of the Z-boson mass and its running up to high energies.

Author: ZAPLATILEK, Ota

Presenter: ZAPLATILEK, Ota

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **24** Type: **not specified**

Charged particle and underlying event measurements with the ATLAS detector

Tuesday 25 March 2025 15:06 (20 minutes)

In this talk, recent measurements of distributions sensitive to the underlying event, the hadronic activity observed in relationship with the hard scattering in the event, by the ATLAS experiment are presented. Underlying event observables like the average particle multiplicity and the transverse momentum sum are measured for Kaons as Lambda baryons as a function of the leading track-jet and are compared to MC predictions which in general fail to describe the data. In addition, a recent measurement of charged-particle multiplicities in diffractive pp collisions are presented. Events are classified using the ATLAS forward proton tagging.

Author: GWENLAN, Claire (University of Oxford (GB))

Presenter: GWENLAN, Claire (University of Oxford (GB))

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **25** Type: **not specified**

Measurements of W, Z and Drell-Yan processes in ATLAS

Wednesday 26 March 2025 15:06 (20 minutes)

The study of the production of single W and Z bosons at the LHC, inclusive and in association with jets, provides stringent tests of the electroweak theory and perturbative QCD. The ATLAS experiment has measured the W boson production cross section and the W-boson charge asymmetry as a function of lepton rapidity in special LHC runs with reduced instantaneous luminosity at 5 and 13 TeV. Measurements of the charged- and neutral-current Drell-Yan cross section have been performed differentially up to high energies. Recent results by the ATLAS experiment of Z+jets production using a novel machine-learning approach to measure multi-differential cross sections of the kinematics of the Z boson decay products and the jets are presented. Measurements of W-boson production in association with a high-transverse momentum jet produced collinearly with the W boson are discussed. These measurements are compared to predictions from state-of-the-art perturbative QCD predictions and from MC generators, employing multi-jet matching and merging techniques.

Author: KRAUS, Johanna Wanda (Bergische Universitaet Wuppertal (DE))

Presenter: KRAUS, Johanna Wanda (Bergische Universitaet Wuppertal (DE))

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **26** Type: **not specified**

Measurements of multiboson production with the ATLAS detector

Tuesday 25 March 2025 11:20 (20 minutes)

Measurements of multiboson production at the LHC are important probes of the electroweak gauge structure of the Standard Model and can constrain anomalous gauge boson couplings. In this talk, recent measurements of diboson production by the ATLAS experiment are presented. Inclusive and differential measurements of WW, ZZ and Zγ production are highlighted. The results are used to constrain anomalous trilinear charged and neutral gauge couplings in an effective field theory approach. Quartic electroweak gauge couplings can be probed in triboson production or the electroweak diboson production in association with two jets. The measurement of electroweak Wγjj and WZjj production will be discussed. In addition, a measurement VVjj production in the semi-leptonic final state as well as the production of three massive electroweak gauge bosons are discussed. These channels provide the most stringent constraints on anomalous quartic gauge couplings. The talk will close with ATLAS'first study of polarised scattering of two W bosons with the same electric charge, a fundamental test of electroweak symmetry breaking with the Higgs mechanism.

Author: DOUGAN, Patrick (The University of Manchester (GB))

Presenter: DOUGAN, Patrick (The University of Manchester (GB))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **27** Type: **not specified**

New techniques for reconstructing and calibrating hadronic objects with ATLAS

Tuesday 25 March 2025 11:00 (20 minutes)

The precision and reach of physics analyses at the LHC is often tied to the performance of hadronic object reconstruction & calibration, with any incremental gains in understanding & reduced uncertainties being impactful on ATLAS results. Recent refinements to the reconstruction and calibration procedures for jets & missing energy by the ATLAS collaboration has resulted in reduced uncertainties, improved pileup stability and overall performance gains. In this contribution, highlights of these developments will be presented.

Author: PIRTTIKOSKI, Antti (Universite de Geneve (CH))

Presenter: PIRTTIKOSKI, Antti (Universite de Geneve (CH))

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **28** Type: **not specified**

Classifying hadronic objects in ATLAS with ML/AI algorithms

Tuesday 25 March 2025 11:22 (20 minutes)

Hadronic object reconstruction & classification is one of the most promising settings for cutting-edge machine learning and artificial intelligence algorithms at the LHC. In this contribution, highlights of ML/AI applications by ATLAS to QCD and boosted-object identification, MET reconstruction and other tasks will be presented.

Author: ČEPAITIS, Vilius (Université de Genève (CH))

Presenter: ČEPAITIS, Vilius (Université de Genève (CH))

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **29** Type: **not specified**

ATLAS Searches for Supersymmetry

Tuesday 25 March 2025 11:40 (20 minutes)

Supersymmetry (SUSY) provides elegant solutions to several problems in the Standard Model, and searches for SUSY particles are an important component of the LHC physics program. The direct production of electroweak SUSY particles, including sleptons, charginos, and neutralinos, is a particularly interesting area with connections to dark matter and the naturalness of the Higgs mass. Naturalness arguments also favour supersymmetric partners of the gluons and third-generation quarks with masses light enough to be produced at the LHC. This talk will highlight the most recent results of searches performed by the ATLAS experiment for supersymmetric particles, considering both electroweak and strong production modes. With increasing mass bounds on more classical MSSM scenarios other variations of supersymmetry become increasingly interesting. Results for compressed, non-minimal, and R-parity violating scenarios and recent interpretations in the context of the pMSSM are also presented.

Author: POTTER, Tina (University of Cambridge (GB))

Presenter: POTTER, Tina (University of Cambridge (GB))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **30** Type: **not specified**

ATLAS Searches for new scalars & BSM Higgs decays

Tuesday 25 March 2025 16:00 (20 minutes)

The discovery of the Higgs boson with the mass of about 125 GeV completed the particle content predicted by the Standard Model. Even though this model is well established and consistent with many measurements, it is not capable to solely explain some observations. Many extensions of the Standard Model addressing such shortcomings introduce additional Higgs bosons, beyond-the-Standard-Model couplings to the Higgs boson, or new particles decaying into Higgs bosons. In this talk, the latest searches in the Higgs sector by the ATLAS experiment are reported.

Author: BELLOS, Panagiotis (University of Birmingham (GB))

Presenter: BELLOS, Panagiotis (University of Birmingham (GB))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **31** Type: **not specified**

Probing initial state effects in nuclear collisions via dijet and spectator neutron measurements with the ATLAS detector

The measurement of dijets in proton-lead collisions at the LHC offers unique possibilities for investigating both nuclear and nucleon initial state effects as a function of parton scattering kinematics. In particular, color fluctuation effects can significantly alter the average interaction strength of the proton, affecting the number of nucleon-nucleon interactions with the Pb nucleus and, therefore, the event activity. Both event activity and break-up neutrons, detected by Zero Degree Calorimeters, are common estimators used to assess the geometry of the p+Pb collision. This talk presents recent results obtained through the analysis of dijet events in $\sqrt{s_{\mathrm{NN}}} = 8.16$ TeV \textit{p}+Pb data collected by ATLAS in 2016. ATLAS has measured the sensitivity of both forward transverse energy and zero-degree spectator neutron energy to changes in the Bjorken-x of the parton originating from the proton (x_p) in the hard-scattering. Both of these estimators exhibit a systematic negative bias in events characterized by a high x_p, although the spectator neutron energy is found to be much less sensitive to these selections than the forward transverse energy. By measuring geometry estimators in well-separated regions of rapidity, this result can provide complementary constraints for color fluctuation modeling. Furthermore, the spectator neutron energy is a novel observable that reflects the number of wounded nucleons and the dynamics of nuclear evaporation.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **32** Type: **not specified**

Measurement of dijet photoproduction in ultraperipheral Pb+Pb collisions with ATLAS

In ultra-relativistic heavy ion collisions, the charged ions produce an intense flux of equivalent photons. Photon-induced processes are the dominant interaction mechanism when the colliding nuclei have an impact parameter larger than the nuclear diameter. In these ultra-peripheral collisions (UPCs), the photon provides a clean, energetic probe of the partonic structure of the nucleus, analogous to deep inelastic scattering. This talk presents a measurement of jet production in UPCs performed with the ATLAS detector using high-statistics 2018 Pb+Pb data. Events are selected using requirements on jet production, rapidity gaps, and forward neutron emission to identify inclusive photo-nuclear hard-scattering processes. These measurements also include detailed studies of rapidity gap distributions and nuclear break-up effects, allowing for precise comparisons between data and theory for inclusive photo-nuclear processes. The measured cross-sections are compared to theoretical models in phase-space regions where significant nuclear PDF modifications are expected but not well constrained by world data, demonstrating the potential of these data to provide a strong new constraint on nPDF effects.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **33** Type: **not specified**

Characterizing the bulk properties of photonuclear collisions with ATLAS measurements of inclusive and strange particle production

Tuesday 25 March 2025 14:44 (20 minutes)

Ultraperipheral collisions of relativistic heavy ion beams lead to a diverse set of photon-nucleus (photonuclear) interactions. Measurements of particles produced in photonuclear reactions can shed light on the QCD dynamics of these novel, extremely asymmetric colliding systems, with energies between those available at RHIC and the LHC. Previous studies by ATLAS have characterized photonuclear collisions through inclusive charged hadron measurements, and have observed elliptic and triangular flow coefficients in these events. This talk presents a measurement of charged hadron production and, for the first time, measurements of identified hadron yields in high-multiplicity photonuclear collisions using 5.02 TeV Pb+Pb data collected in 2018 by ATLAS, with a dedicated photo-nuclear event trigger. The yields of charged hadrons and, for the first time, identified strange hadrons (K^0_S, Λ, and Ξ) are shown differentially in rapidity, transverse momentum, and event multiplicity. These new results shed light on potential QGP formation in ultraperipheral collisions via observables sensitive to radial flow, enhanced baryon-to-meson ratios, and strangeness enhancement. These results are compared to 5.02 TeV p+Pb data collected by ATLAS in 2016, at the same event multiplicities. The results are also compared with calculations from DPMJET and hydrodynamic-based models predicting flow even in these ultraperipheral collisions.

Author: GILBERT, Benjamin Jacob (Lawrence Livermore Nat. Laboratory (US))

Presenter: GILBERT, Benjamin Jacob (Lawrence Livermore Nat. Laboratory (US))

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **34** Type: **not specified**

Results on photon-photon scattering processes in ultra-peripheral Pb+Pb collisions with ATLAS

In ultra-relativistic heavy-ion collisions, large rates of $\gamma\gamma$ processes occur through the interaction of the large electromagnetic fields of the nuclei. These $\gamma\gamma$ interactions enable the study of processes potentially sensitive to physics beyond the Standard Model. In ultra-peripheral collisions (UPCs), characterized by large impact parameter between the nuclei, the outgoing particles exhibit back-to-back production in the transverse plane, which provides precise and efficient identification. This talk presents an overview of recent ATLAS measurements potentially senstive to physics beyond the Standard Model, including the production of tau leptons, light-by-light scattering, or the production of magnetic monopoles. Measurements of tau lepton production help to constrain its anomalous magnetic moment, a quantity potentially sensitive to physics beyond the Standard Model. Results will be presented on measurements of light-by-light scattering which may be used to set limits on the existence of axion-like-particles (ALPs). Also presented is a more recent search for monopole-pair production in UPCs with monopole masses ranging from 20–150 GeV. The results are compared with a leading-order model of spin-1/2 particle production from photon–photon fusion and a recently developed semi-classical model that includes non-perturbative cross section calculations.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **35** Type: **not specified**

Measurement of the sensitivity of two-particle correlations in pp collisions to the presence of hard scatterings

A key open question in the study of multi-particle production in high-energy pp collisions is the relationship between the "ridge" - observed azimuthal correlations between particles in the underlying event that extend over all rapidities and hard or semi-hard scattering processes. In particular, it is not known whether jets or their soft fragments are correlated with particles in the underlying event. This talk presents measurements of two-particle correlations in pp collisions at $\sqrt{s} = 13$ TeV with two different particle-pair selections. In the first case, charged particles associated with jets are excluded from the correlation analysis. This shows that excluding charged particles associated with jets does not affect the measured correlations. In the second case, correlations are measured between particles within jets and charged particles from the underlying event. Particles associated with jets do not exhibit any significant azimuthal correlations with the underlying event, ruling out hard processes contributing to the ridge.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **36** Type: **not specified**

Probing the nature of electroweak symmetry breaking with Higgs boson pairs in ATLAS

Wednesday 26 March 2025 09:40 (20 minutes)

In the Standard Model, the ground state of the Higgs field is not found at zero but instead corresponds to one of the degenerate solutions minimising the Higgs potential. In turn, this spontaneous electroweak symmetry breaking provides a mechanism for the mass generation of nearly all fundamental particles. The Standard Model makes a definite prediction for the Higgs boson self-coupling and thereby the shape of the Higgs potential. Experimentally, both can be probed through the production of Higgs boson pairs (HH), a rare process that presently receives a lot of attention at the LHC. In this talk, the latest HH searches by the ATLAS experiment are reported, with emphasis on the results obtained with the full LHC Run 2 dataset at 13 TeV. Non-resonant HH search results are interpreted both in terms of sensitivity to the Standard Model and as limits on the Higgs boson self-coupling and the quartic VVHH coupling. The Higgs boson self-coupling can be also constrained by exploiting higher-order electroweak corrections to single Higgs boson production. A combined measurement of both results yields the overall highest precision, and reduces model dependence by allowing for the simultaneous determination of the single Higgs boson couplings. Additionally, extrapolations of recent HH results towards the High Luminosity LHC upgrade are also discussed. Many new physics models predict the existence of resonances decaying into two bosons, including the Higgs boson or new scalar S bosons making these important signatures in the search for new physics. Searches for HH or SH resonances have been performed in various final states. In some of these searches, jet substructure techniques are used to disentangle the hadronic decay products in highly boosted configurations.Recent ATLAS searches with Run 2 data collected at the LHC and explains the experimental methods used, including vector- and Higgs-boson-tagging techniques are presented.

Author: EL JARRARI, Hassnae (CERN)

Presenter: EL JARRARI, Hassnae (CERN)

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **37** Type: **not specified**

Measurements of Higgs boson properties (mass, width, and Spin/CP) with the ATLAS detector

Tuesday 25 March 2025 14:00 (20 minutes)

This talk presents precise measurement of the properties of the Higgs boson, including its mass, total width, spin, and CP quantum number using the full dataset collected in pp collisions at 13 TeV during Run 2 and at 13.6 TeV during Run 3 of the LHC. The measurements are performed in various Higgs boson production and decay modes, as well as their combinations. Observation of deviations between these measurements and Standard Model (SM) predictions would be a sign of possible new phenomena beyond the SM

Author: SOBERI, Firdaus (The University of Edinburgh (GB))

Presenter: SOBERI, Firdaus (The University of Edinburgh (GB))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **38** Type: **not specified**

Measurements of Higgs boson production and decay rates with the ATLAS experiment

Tuesday 25 March 2025 14:20 (20 minutes)

The event rates and kinematics of Higgs boson production and decay processes at the LHC are sensitive probes of possible new phenomena beyond the Standard Model (BSM). This talk presents precise measurements of Higgs boson production and decay rates, obtained using the full Run 2 and partial Run 3 pp collision dataset collected by the ATLAS experiment at 13 TeV and 13.6 TeV. These include total and fiducial cross-sections for the main Higgs boson processes as well as branching ratios into final states with bosons and fermions. Differential cross-sections in a variety of observables are also reported, as well as a fine-grained description of the Higgs boson production kinematics within the Simplified Template Cross-section (STXS) framework. Additionally, several rare Higgs boson processes predicted in the SM, such as production in association with c-quarks, decays to a Z boson and a photon, and decays to a pair of muons will be discussed. The observation of one of these processes could open new windows for the study of Higgs boson couplings, or provide evidence for physics beyond the Standard Model.

Author: YAN, Siyuan (University of Glasgow (GB))

Presenter: YAN, Siyuan (University of Glasgow (GB))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **39** Type: **not specified**

Flavour Tagging with Graph Neural Network with the ATLAS Detector

Tuesday 25 March 2025 11:44 (20 minutes)

The identification of jets containing b-hadrons is key to many physics analyses at the LHC, including measurements involving Higgs bosons or top quarks, and searches for physics beyond the Standard Model. In this contribution, the most recent enhancements in the capability of ATLAS to separate b-jets from jets stemming from lighter quarks will be presented. The improved performance originates from the usage of state-of-the-art machine learning algorithms based on graph networks. A factor of more than 2 to reject light- and c-quark-initiated jet is observed compared to the current performance. The expected performance of this algorithm at the High-Luminosity LHC (HL-LHC) will also be discussed in detail.

Author: SANTOS, Helena (LIP - Lisbon)

Presenter: SANTOS, Helena (LIP - Lisbon)

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **40** Type: **not specified**

Boosted Higgs boson Tagging with Graph Neural Network with the ATLAS Detector

Tuesday 25 March 2025 14:40 (20 minutes)

The pursuit of detecting high-energy Higgs boson decays into a pair of heavy quarks is a prominent focus within the ATLAS experiment's physics program. In this study, we introduce an innovative tagger that leverages graph networks and employs tracks as input constituents. Our approach demonstrates a substantial improvement when compared to the previous boosted Higgs boson tagger employed by the ATLAS experiment, as observed through extensive Monte Carlo sample analyses. We will present the significant improvements achieved and delve into the details of the training procedure, emphasizing techniques employed to mitigate the tagger's dependency on the reconstructed jet mass.

Author: Mr LEINONEN, Waltteri (Nikhef National institute for subatomic physics (NL))

Presenter: Mr LEINONEN, Waltteri (Nikhef National institute for subatomic physics (NL))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **41** Type: **not specified**

b-jet Triggers in run 3

Tuesday 25 March 2025 12:06 (20 minutes)

A number of flagship analyses in the ATLAS experiment rely on real-time b-tagging to efficiently record data. In run 3, the jet and b-jet trigger was updated with state of the art machine learning, to reduce background rates and improve efficiency, while remaining within the constraints of the trigger hardware. We will discuss the design, optimization, deployment, and validation of the ATLAS run 3 b-jet triggers, and their impact several important physics analyses.

Author: FRANCHELLUCCI, Stefano (Universite de Geneve (CH))

Presenter: FRANCHELLUCCI, Stefano (Universite de Geneve (CH))

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **42** Type: **not specified**

Searches for BSM physics using challenging and long-lived signatures with the ATLAS detector

Wednesday 26 March 2025 11:00 (20 minutes)

Various theories beyond the Standard Model predict new, long-lived particles with unique signatures which are difficult to reconstruct and for which estimating the background rates is also a challenge. Signatures from displaced and/or delayed decays anywhere from the inner detector to the muon spectrometer, as well as those of new particles with fractional or multiple values of the charge of the electron or high mass stable charged particles are all examples of experimentally demanding signatures. The talk will focus on the most recent results using 13 TeV pp collision data collected by the ATLAS detector.

Author: PAGAN GRISO, Simone (Lawrence Berkeley National Lab. (US))

Presenter: PAGAN GRISO, Simone (Lawrence Berkeley National Lab. (US))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **43** Type: **not specified**

Searches for Exotic Heavy Resonances and Dark Matter with the ATLAS detector

Tuesday 25 March 2025 16:20 (20 minutes)

Many new physics models predict the existence of new, heavy particles. This talk summarises recent ATLAS searches for Beyond-the-Standard-Model heavy resonances which decay to pairs of quarks, or leptons, using Run 2 and or Run 3 data collected at the LHC, as well as searches for Dark Matter with the same datasets.

Author: PIAZZA, Federica (University of Oregon (US))

Presenter: PIAZZA, Federica (University of Oregon (US))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **44** Type: **not specified**

ATLAS Searches for Lepto-Quarks, Vectorlike-Leptons and Vectorlike-Quarks

Wednesday 26 March 2025 09:20 (20 minutes)

The Standard Model of Particle Physics explains many natural phenomena yet remains incomplete. Leptoquarks (LQs) are hypothetical particles predicted to mediate interactions between quarks and leptons, bridging the gap between the two fundamental classes of particles. Vectorlike quarks (VLQs) and Vectorlike leptons (VLLs) lie at the heart of many extensions seeking to address the Hierarchy Problem, as they can naturally cancel the mass divergence for the Higgs boson. This talk will present the new results from LQ and VLQ searches with the ATLAS detector using the Run-2 dataset.

Author: SIMPSON, Harry (University of Sussex (GB))

Presenter: SIMPSON, Harry (University of Sussex (GB))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **45** Type: **not specified**

Recent B-physics results from ATLAS

Wednesday 26 March 2025 11:22 (20 minutes)

Studying heavy-flavour hadron properties provides a extensive tests for various QCD predictions as well as a means to probe the Standard Model validity. ATLAS experiment, being a general-purpose detector at LHC, is particularly successful in such measurements with final states involving muons, thanks to large collected integrated luminosity and precise muon reconstruction and triggering. This talk will overview the recent ATLAS results on b hadron production and decay properties and spectroscopy of exotic states.

Author: SEIDEL, Sally (University of New Mexico (US))

Presenter: SEIDEL, Sally (University of New Mexico (US))

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **46** Type: **not specified**

Performance of the ATLAS Muon Spectrometer Detectors during Run3 data taking

Wednesday 26 March 2025 14:44 (22 minutes)

With the conclusion of proton-proton collision data-taking in 2024, the ATLAS experiment has now integrated a luminosity exceeding 180 fbˆ{-1} during the Run 3 period, which began in July 2022 following Long Shutdown 2 (LS2). During LS2, a series of detector upgrades were implemented, including the installation of the New Small Wheel (NSW), a major upgrade that involved replacing the innermost stations of the Muon Spectrometer endcaps. The ATLAS Muon Spectrometer, the largest muon system ever built at colliders, now comprises both legacy gaseous detectors —Monitored Drift Tubes (MDT), Thin Gap Chambers (TGC), and Resistive Plate Chambers (RPC) —which have been in operation for over 15 years, as well as newer technologies like Micromegas and small-strip TGCs in the NSW. These new systems are now in stable operation following an extensive phase of construction and commissioning, providing enhanced muon tracking and trigger capabilities. This presentation will cover the performance of the Muon system, focusing on the stability of the legacy detectors over time, their ability to handle increasing luminosity and associated irradiation levels, and studies on detector ageing. Emphasis will be placed on the NSW upgrade, including the strategies adopted for simulation, alignment, track reconstruction, and trigger.

Author: MANCO, Giulia (Pavia University and INFN (IT))

Presenter: MANCO, Giulia (Pavia University and INFN (IT))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **47** Type: **not specified**

ATLAS Muon Detectors upgrades for High Luminosity LHC

Tuesday 25 March 2025 09:44 (22 minutes)

The muon spectrometer of the ATLAS detector will undergo a substantial upgrade during the Phase-II upgrade in Long Shutdown 3 to meet the operational demands of the High- Luminosity LHC. Most of the electronics for the Monitored Drift Tube (MDT) chambers, Resistive Plate Chambers (RPC), and Thin Gap Chambers (TGC) will be replaced to ensure compatibility with the higher trigger rates and extended latencies required for the new level-0 trigger. The MDT chambers will be integrated into the level-0 trigger to sharpen the momentum threshold. Additional RPC chambers will be installed in the inner barrel layer to enhance the acceptance and robustness of the trigger. Some MDT chambers in the inner barrel layer will be replaced with new small-diameter MDTs to optimize performance. New TGC triplet chambers will be installed in the barrel-endcap transition region, replacing the current TGC doublets to reduce the high trigger rate caused by random coincidences in this area. Additionally, the power systems for the RPC, TGC, and MDT chambers, along with their associated electronics, will be replaced due to component obsolescence, ageing, and radiation damage. This contribution will provide an overview of the upgrade challenges, the current status of the projects, prototype and production results.

Authors: KHORIAULI, Gia (Julius Max. Universitaet Wuerzburg (DE)); KHORIAULI, Gia (Julius Max. Universitaet Wuerzburg (DE))

Presenters: KHORIAULI, Gia (Julius Max. Universitaet Wuerzburg (DE)); KHORIAULI, Gia (Julius Max. Universitaet Wuerzburg (DE))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **49** Type: **not specified**

ATLAS ITk Pixel Detector Overview

Tuesday 25 March 2025 10:06 (22 minutes)

In the high-luminosity era of the Large Hadron Collider, the instantaneous luminosity is expected to reach unprecedented values, resulting in up to 200 proton-proton interactions in a typical bunch crossing. To cope with the resulting increase in occupancy, bandwidth and radiation damage, the ATLAS Inner Detector will be replaced by an all-silicon system, the Inner Tracker (ITk). The innermost part of the ITk will consist of a pixel detector, with an active area of about 13 mˆ2. To deal with the changing requirements in terms of radiation hardness, power dissipation and production yield, several silicon sensor technologies equipped with novel ASICs connecting by bump-bonding technique will be employed in the five barrel and endcap layers. As a timeline, it is facing to pre-production of components, sensor, building modules, mechanical structures and services.

Authors: CRESCIOLI, Francesco (Univ. P. et Marie Curie (Paris VI) (FR)); CRESCIOLI, Francesco (Centre National de la Recherche Scientifique (FR))

Presenters: CRESCIOLI, Francesco (Univ. P. et Marie Curie (Paris VI) (FR)); CRESCIOLI, Francesco (Centre National de la Recherche Scientifique (FR))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **50** Type: **not specified**

The ATLAS ITk Strip Detector Overview

Wednesday 26 March 2025 11:44 (22 minutes)

ATLAS is currently preparing for the HL-LHC upgrade, with an all-silicon Inner Tracker (ITk) that will replace the current Inner Detector. The ITk will feature a pixel detector surrounded by a strip detector, with the strip system consisting of 4 barrel layers and 6 endcap disks. After completion of final design reviews in key areas, such as Sensors, Modules, Front-End electronics and ASICs, a large-scale prototyping program has been completed in all areas successfully. We present an overview of the Strip System, and highlight the final design choices of sensors, module designs and ASICs. We will summarise the current status of pre-production and production on various detector components, with an emphasis on QA and QC procedures.

Author: COLANGELI, Luca Sesto (University of Toronto (CA))

Presenter: COLANGELI, Luca Sesto (University of Toronto (CA))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **54** Type: **not specified**

The ATLAS Trigger System

Wednesday 26 March 2025 14:00 (22 minutes)

The ATLAS experiment in the LHC Run 3 uses a two-level trigger system to select events of interest to reduce the 40 MHz bunch crossing rate to a recorded rate of up to 3 kHz of fully-built physics events. The trigger system is composed of a hardware based Level-1 trigger and a software based High Level Trigger. The selection of events by the High Level Trigger is based on a wide variety of reconstructed objects, including leptons, photons, jets, b-jets, missing transverse energy, and B-hadrons in order to cover the full range of the ATLAS physics programme. We will present an overview of improvements in the reconstruction, calibration, and performance of the different trigger objects, as well as computational performance of the High Level Trigger system.

Author: RIMOLDI, Marco (CERN)

Presenter: RIMOLDI, Marco (CERN)

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **55** Type: **not specified**

The upgrade of the ATLAS Trigger and Data Acquisition system for the High Luminosity LHC

Wednesday 26 March 2025 14:22 (22 minutes)

The ATLAS experiment at CERN is constructing upgraded system for the "High Luminosity LHC", with collisions due to start in 2030. In order to deliver an order of magnitude more data than previous LHC runs, 14 TeV protons will collide with an instantaneous luminosity of up to 7.5 x 10e34 cmˆ-2sˆ-1, resulting in much higher pileup and data rates than the current experiment was designed to handle. While this is essential to realise the physics programme, it presents a huge challenge for the detector, trigger, data acquisition and computing. The detector upgrades themselves also present new requirements and opportunities for the trigger and data acquisition system. The design of the TDAQ upgrade comprises: a hardware-based low-latency real-time Trigger operating at 40 MHz, Data Acquisition which combines custom readout with commodity hardware and networking to deal with 4.6 TB/s input, and an Event Filter running at 1 MHz which combines offline-like algorithms on a large commodity compute service with the potential to be augmented by commercial accelerators . Commodity servers and networks are used as far as possible, with custom ATCA boards, high speed links and powerful FPGAs deployed in the low-latency parts of the system. Offline-style clustering and jet-finding in FPGAs, and accelerated track reconstruction are designed to combat pileup in the Trigger and Event Filter respectively. This contribution will report recent progress on the design, technology and construction of the system. The physics motivation and expected performance will be shown for key physics processes.

Author: ROY-GARAND, Sebastien (University of Toronto (CA))

Presenter: ROY-GARAND, Sebastien (University of Toronto (CA))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **56** Type: **not specified**

Performance and calibration of the ATLAS Tile Calorimeter

Wednesday 26 March 2025 09:00 (22 minutes)

The Tile Calorimeter (TileCal) is a sampling hadronic calorimeter covering the central region of the ATLAS experiment, with steel as absorber and plastic scintillators as active medium. The scintillators are read-out by the wavelength shifting fibres coupled to the photomultiplier tubes (PMTs). The analogue signals from the PMTs are amplified, shaped, digitized by sampling the signal every 25 ns and stored on detector until a trigger decision is received. The TileCal front-end electronics reads out the signals produced by about 10000 channels measuring energies ranging from about 30 MeV to about 2 TeV. Each stage of the signal production from scintillation light to the signal reconstruction is monitored and calibrated. During LHC Run-2, high-momentum isolated muons have been used to study and validate the electromagnetic scale, while hadronic response has been probed with isolated hadrons. The calorimeter time resolution has been studied with multi-jet events. First results using early LHC Run-3 data will be shown. A summary of the performance results, including the calibration, stability, absolute energy scale, uniformity and time resolution, will be presented.

Author: ASTALOS, Robert (Comenius University (SK))

Presenter: ASTALOS, Robert (Comenius University (SK))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **57** Type: **not specified**

Upgrade of ATLAS Hadronic Tile Calorimeter for the High Luminosity LHC

Wednesday 26 March 2025 09:44 (22 minutes)

The Tile Calorimeter (TileCal) is a sampling hadronic calorimeter covering the central region of the ATLAS experiment, with steel as absorber and plastic scintillators as active medium. The High-Luminosity phase of LHC, delivering five times the LHC nominal instantaneous luminosity, is expected to begin in 2029. TileCal will require new electronics to meet the requirements of a 1 MHz trigger, higher ambient radiation, and to ensure better performance under high pile-up conditions. Both the on- and off-detector TileCal electronics will be replaced during the shutdown of 2026-2028. PMT signals from every TileCal cell will be digitized and sent directly to the back-end electronics, where the signals are reconstructed, stored, and sent to the first level of trigger at a rate of 40 MHz. This will provide better precision of the calorimeter signals used by the trigger system and will allow the development of more complex trigger algorithms. The modular front-end electronics feature radiation-tolerant commercial off-the-shelf components and redundant design to minimise single points of failure. The timing, control and communication interface with the off-detector electronics is implemented with modern Field Programmable Gate Arrays (FPGAs) and high speed fibre optic links running up to 9.6 Gb/s. The TileCal upgrade program has included extensive R&D and test beam studies. A Demonstrator module with reverse compatibility with the existing system was inserted in ATLAS in August 2019 for testing in actual detector conditions. The ongoing developments for on- and off-detector systems, together with expected performance characteristics and results of test-beam campaigns with the electronics prototypes will be discussed.

Authors: RAPHEEHA, Phuti Ntsoko; RAPHEEHA, Phuti (University of the Witwatersrand (ZA))

Co-authors: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT)); TSOTSKOLAURI, Pavle (Ivane Javakhishvili Tbilisi State University (GE))

Presenters: TSOTSKOLAURI, Pavle (Ivane Javakhishvili Tbilisi State University (GE)); RAPHEEHA, Phuti Ntsoko; RAPHEEHA, Phuti (University of the Witwatersrand (ZA))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **58** Type: **not specified**

Overview of ATLAS forward proton detectors: status, performance and new physics results

Tuesday 25 March 2025 15:06 (20 minutes)

A key focus of the physics program at the LHC is the study of head-on proton-proton collisions. However, an important class of physics can be studied for cases where the protons narrowly miss one another and remain intact. In such cases, the electromagnetic fields surrounding the protons can interact producing high-energy photon-photon collisions. Alternatively, interactions mediated by the strong force can also result in intact forward scattered protons, providing probes of quantum chromodynamics (QCD). In order to aid identification and provide unique information about these rare interactions, instrumentation to detect and measure protons scattered through very small angles is installed in the beam pipe far downstream of the interaction point. We describe the ATLAS Forward Proton 'Roman Pot' Detectors (AFP and ALFA), including their performance to date, covering Tracking and Time-of-Flight Detectors as well as the associated electronics, trigger, readout, detector control and data quality monitoring. The physics interest, beam optics and detector options for the extension of the programme into the High-Luminosity LHC (HL-LHC) era are also discussed. Finally, a glimpse on the newest results will be given.

Author: CLAWSON, Savannah (Deutsches Elektronen-Synchrotron (DE))

Presenter: CLAWSON, Savannah (Deutsches Elektronen-Synchrotron (DE))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **59** Type: **not specified**

Online track reconstruction with graph neural networks on FPGAs for the ATLAS experiment

Tuesday 25 March 2025 11:54 (22 minutes)

The High-Luminosity Large Hadron Collider (HL-LHC) at CERN marks a new era for high-energy particle physics, demanding significant upgrades to the ATLAS Trigger and Data Acquisition (TDAQ) system. Central to these upgrades is the enhancement of online software tracking capabilities to meet the unprecedented data rates and complexity of HL-LHC operations. This study investigates the deployment of Graph Neural Networks (GNNs) on Field-Programmable Gate Arrays (FPGAs) within the Event Filter system of the ATLAS experiment. Focusing on the reconstruction of tracks in the new all-silicon ATLAS Inner Tracker, we detail a GNN-based tracking pipeline comprising graph construction, edge classification via interaction networks, and segmentation into track candidates. Key optimizations, including model hyperparameter tuning, pruning, quantization-aware training, and sequential processing of detector regions, are explored to reduce FPGA resource utilization and maximize throughput. Our results demonstrate the potential of this approach to achieve high tracking efficiency and low fake rates, aligning with the stringent requirements of the ATLAS Event Filter system for HL-LHC operations.

Author: PARAJULI, Santosh (Univ. Illinois at Urbana Champaign (US))

Presenter: PARAJULI, Santosh (Univ. Illinois at Urbana Champaign (US))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **60** Type: **not specified**

New measurement of $K^+ \to \pi^+\nu\bar{\nu}$ branching ratio at the NA62 experiment

Wednesday 26 March 2025 09:00 (20 minutes)

The $K^+ \to \pi^+\nu\bar{\nu}$ decay is a golden mode for flavour physics. Its branching ratio is predicted with high precision by the Standard Model to be less than 10^{-10}, and this decay mode is highly sensitive to indirect effects of new physics up to the highest mass scales. A new measurement of the $K^+ \to \pi^+\nu\bar{\nu}$ decay by the NA62 experiment at the CERN SPS is presented, using data collected in 2021 and 2022. This new dataset was collected after modifications to the beamline and detectors and at a higher instantaneous beam intensity with respect to the previous 2016–2018 data taking. Using the NA62 datasets from 2016–2022, a new measurement of $\mathcal{B}(K^+ \to \pi^+\nu\bar{\nu}) = \left(13.0^{+3.3}_{-2.9}\right) \times 10^{-11}$ is reported, and for the first time the $K^+ \to \pi^+\nu\bar{\nu}$ decay is observed with a significance exceeding 5σ.

Author: FIORENZA, Renato (INFN Napoli)

Presenter: FIORENZA, Renato (INFN Napoli)

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **61** Type: **not specified**

Asymmetry measurement of far-forward neutral particles in the RHICf experiment

Tuesday 25 March 2025 11:25 (25 minutes)

The RHICf experiment installed an electromagnetic calorimeter in front of the Zero-Degree Calorimeter (ZDC) of the RHIC-STAR experiment in 2017 to measure the transverse-spin asymmetries of the far-forward neutral particles produced from transversely polarized proton collisions at RHIC. It has been known that the far-forward neutrons have a large transverse-spin asymmetry in RHIC transversely polarized proton collisions, and the ZDC of RHIC serves as a polarimeter to monitor the polarization of the protons at the collision point. The electromagnetic calorimeter installed in the RHICf experiment provided high-precision position information, and by moving the installation position, the kinematic region that can be measured was greatly expanded and the precision of measurement was greatly improved. In addition to neutrons, we also measured the far-forward asymmetry of neutral pions and found that neutral pions also have a large transverse-spin asymmetry in this kinematic region. For these neutral particles, we are further conducting a combined data analysis with the detectors of the STAR experiment to elucidate the far-forward particle production mechanism.

Author: NAKAGAWA, Itaru (RIKEN)

Co-author: GOTO, Yuji (RIKEN (JP))

Presenters: NAKAGAWA, Itaru (RIKEN); GOTO, Yuji (RIKEN (JP))

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **62** Type: **not specified**

Connecting Scales: RGE effects in the SMEFT from LHC to Future Colliders

Tuesday 25 March 2025 12:00 (20 minutes)

Global interpretations of particle physics data within the framework of the Standard Model Effective Field Theory (SMEFT), including their matching to UV-complete models, involve energy scales potentially spanning several orders of magnitude.
Relating these measurements in terms of a common energy scale is enabled by the Renormalisation Group Equations (RGEs).
Here we present a systematic assessment of the impact of RGEs in a global SMEFT fit of LEP and LHC data within the SMEFiT framework.
Additionally, we evaluate the role of RGEs in matching to representative BSM models at tree-level and one-loop, and quantify the impact of logarithmic QCD and electroweak corrections resummed in the RGEs for future collider sensitivity projections, particularly for FCC-ee.

Authors: VRYONIDOU, Eleni (The University of Manchester (GB)); ROJO CHACON, Juan (Nikhef National institute for subatomic physics (NL)); MANTANI, Luca (IFIC, Valencia)

Presenter: MANTANI, Luca (IFIC, Valencia)

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **63** Type: **not specified**

Colibri: a flexible framework for Bayesian analysis in PDF fits

Wednesday 26 March 2025 11:44 (22 minutes)

Accurately propagating uncertainties is essential for parton distribution functions (PDFs), particularly with the high-precision data expected from the HL-LHC. Traditional methodologies often struggle with strong non-linear dependencies in parameters, underscoring the need for innovative approaches. In this talk, we introduce Colibri, a flexible Bayesian analysis framework for PDFs, enabling simple implementation of diverse PDF models.
As a key application, we discuss a model allowing for realistic global PDF analyses by parameterizing PDFs with a linear model, showcasing how the Bayesian workflow facilitates robust model selection. We will showcase state-of-the-art results, highlighting the framework's potential for simultaneous determination of PDF parameters and SM (or BSM) ones, paving the way for advancements in the high-precision era.

Authors: MANTANI, Luca (IFIC, Valencia); UBIALI, Maria (University of Cambridge (GB)); COSTANTINI, Mark

Presenter: MANTANI, Luca (IFIC, Valencia)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **64** Type: **not specified**

One-loop corrections to single and double inclusive hadron production in DIS at small x: signatures of gluon saturation at the Electron-Ion Collider

We calculate the one loop corrections to single (SIDIS) and double (DIDIS) inclusive hadron production in DIS at small x using the Color Glass Condensate formalism. It is shown that all soft and UV singularities cancel among themselves. Collinear singularities lead to DGLAP evolution of parton-hadron fragmentation functions while rapidity singularities lead to JIMWLK evolution of dipoles and quadrupoles which appear in the Leading Order expressions. We then focus on SIDIS and consider the limit when the produced hadron transverse momentum is much smaller than the photon virtuality. We show that imposing a kinematic constraint on the JIMWLK evolution leads to the so called Sudakov single and double logs. We discuss the significance of our results for gluon saturation searches at the Electron-Ion Collider.

Author: JALILIAN-MARIAN, Jamal

Presenter: JALILIAN-MARIAN, Jamal

Contribution ID: **66** Type: **not specified**

Probing Weizsacker-Williams Gluon Helicity Distribution in Longitudinally Polarized Electron-Proton Collisions

It is well known that the back-to-back correlation limit of inclusive quark-antiquark dijet production in unpolarized high energy electron-proton collisions can probe the Weizsacker-Williams (WW) gluon distribution at small x. In this talk, we consider double-spin asymmetry for inclusive quark-antiquark dijet production in longitudinally polarized electron proton/nucleus scatterings at high energies. It is shown that in the back-to-back correlation limit, this process uniquely probes the WW gluon helicity distribution. Furthermore, we derive the small-x evolution equation for WW gluon helicity distribution using an operator method. It is found that in the double-logarithmic approximation and in the large-N_c limit, the small-x evolution equation for WW gluon helicity distribution is the same as that for the dipole gluon helicity distribution. The longitudinal double-spin asymmetry for inclusive dijet production can thus facilitate constraining the initial conditions for small-x helicity evolution equations in the upcoming EIC.

Author: Dr LI, Ming (The Ohio State University)

Co-author: Prof. KOVCHEGOV, Yuri

Presenter: Dr LI, Ming (The Ohio State University)

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **67** Type: **not specified**

Higher-order corrections for ttZ production

We present calculations of higher-order QCD and electroweak (EW) corrections to the associated production of a top-antitop quark pair and a Z boson, i.e. $t\bar{t}Z$ production, in proton collisions. We find that the contributions from soft-gluon corrections are numerically dominant and large. We present approximate NNLO (aNNLO) and approximate N^{3}LO (aN^{3}LO) cross sections that include soft corrections on top of the exact NLO QCD result. We also add electroweak corrections through NLO. We compare our aN^{3}LO QCD + NLO EW theoretical results to measurements of total cross sections from the LHC, and we also calculate top-quark differential distributions in transverse momentum and rapidity.

Author: Prof. KIDONAKIS, Nikolaos

Co-author: FOSTER, Chris

Presenter: Prof. KIDONAKIS, Nikolaos

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **68** Type: **not specified**

Semi-Inclusive Deep-Inelastic Scattering at NNLO in QCD

Tuesday 25 March 2025 09:22 (20 minutes)

Semi-inclusive hadron production in deep-inelastic lepton-nucleon scattering (SIDIS) is an important probe of the quark flavor structure of the nucleon and of the fragmentation dynamics of quarks into hadrons. In case of longitudinally polarized beams, SIDIS is a powerful tool for resolving the quark flavor decomposition of the proton's spin structure. I report on the recent calculation of the full next-to-next-to-leading order (NNLO) QCD corrections to the coefficient functions for SIDIS in analytical form. The numerical impact of these corrections for precision physics is illustrated by a detailed phenomenological analysis, by comparison with data from previous experiments and with predictions for the future Electron-Ion Collider (EIC), where SIDIS will represent a key process.

Author: STAGNITTO, Giovanni (University of Milano Bicocca)

Presenter: STAGNITTO, Giovanni (University of Milano Bicocca)

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **69** Type: **not specified**

Hybrid high-energy factorization and evolution at NLO

I present a scheme of NLO computations for generic observables in high-energy collisions within the framework of hybrid high-energy factorization, that is with one off-shell initial-state parton. The scheme is obtained by taking a high-energy limit of the NLO computation in collinear factorization. Terms belonging to the projectile and the target are identified, and the ambiguity of this separation is governed by the Collins-Soper scale muY. The unintegrated PDF is constructed at NLO in terms of the usual PDFs, and its evolution with respect to the scale muY reproduces the Collins-Soper-Sterman equation in the TMD limit (|kT|« muY). The BFKL-Collins-Ellis evolution of the Green's function in the unintegrated PDF takes care of the resummation of high-energy logarithms.

Authors: VAN HAMEREN, Andreas; Dr NEFEDOV, Maxim (IJClab, Orsay)

Presenter: VAN HAMEREN, Andreas

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **70** Type: **not specified**

The azimuthal correlation between the leading jet and the scattered lepton in deep inelastic scattering at HERA

Tuesday 25 March 2025 09:00 (20 minutes)

The azimuthal correlation angle, $\Delta\phi$, between the scattered lepton and the leading jet in deep inelastic $e^{\pm}p$ scattering at HERA has been studied using data collected with the ZEUS detector at a centre-of-mass energy of $\sqrt{s} = 318$ GeV, corresponding to an integrated luminosity of $326\ \mathrm{pb}^{-1}$.
A measurement of jet cross sections in the laboratory frame was made in a fiducial region corresponding to photon virtuality $10\ \mathrm{GeV}^2 < Q^2 < 350\ \mathrm{GeV}^2$, inelasticity $0.04 < y < 0.7$, outgoing lepton energy $E_e > 10$ GeV, lepton polar angle $140^\circ < \theta_e < 180^\circ$, jet transverse momentum $2.5\ \mathrm{GeV} < p_{\mathrm{T,jet}} < 30$ GeV, and jet pseudorapidity $-1.5 < \eta_{\mathrm{jet}} < 1.8$.
Jets were reconstructed using the k_{T} algorithm with the radius parameter $R = 1$.
The leading jet in an event is defined as the jet that carries the highest $p_{\mathrm{T,jet}}$.
Differential cross sections, $d\sigma/d\Delta\phi$, were measured as a function of the azimuthal correlation angle in various ranges of leading-jet transverse momentum, photon virtuality and jet multiplicity.

In this talk, comparisons between the HERA data, perturbative calculations at $\mathcal{O}(\alpha_s^2)$ accuracy, and Monte Carlo predictions with leading-order matrix elements supplemented by parton showering will be presented, providing insights for future experiments, such as the U.S.-based Electron-Ion Collider.

Author: ZENAIEV, Oleksandr

Presenter: ZENAIEV, Oleksandr

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **72** Type: **not specified**

Inclusive and Exclusive Photonuclear Interactions in Ultra-Peripheral Collisions with ALICE

Ultra-peripheral collisions (UPCs) in high-energy heavy-ion collisions provide a unique environment to study a wide range of electromagnetic processes, mediated by virtual photons. In Run 3 of the LHC, the ALICE experiment has begun exploring inclusive photonuclear interactions, where a photon interacts with a nucleus, resulting in its breakup, gamma+A −> X. These interactions include both resolved processes, where the photon fluctuates into a hadronic state and undergoes strong interactions, and direct processes, such as photon-gluon fusion leading to e.g. heavy quark or dijet production. The study of these processes extends our understanding of cold nuclear matter effects and probes the nuclear gluon distribution at low Bjorken-x.

This presentation will showcase the latest results from ALICE on inclusive photonuclear interactions, including transverse momentum and rapidity distributions of charged hadrons. Additionally, new insights from open charm photoproduction in UPCs will be highlighted.

To complement this, the most recent results on exclusive vector meson production, a cornerstone of UPC studies, will also be presented. These measurements provide critical tests of quantum chromodynamics (QCD) in the strong-field regime and offer complementary constraints on the nuclear parton distribution functions.

The combination of inclusive and exclusive UPC studies in ALICE enables a comprehensive investigation of photonuclear dynamics in the high-energy regime, paving the way for deeper insights into the structure and interactions of nuclear matter.

Author: BYLINKIN, Sasha (University of Bergen (NO))

Presenter: BYLINKIN, Sasha (University of Bergen (NO))

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **73** Type: **not specified**

The path to the determination of $\alpha_s(m_Z)$ at $\mathrm{N^3LO_{QCD}} \otimes \mathrm{NLO_{QED}}$ accuracy from a global PDF analysis

Tuesday 25 March 2025 14:44 (22 minutes)

The strong coupling $\alpha_s(Q^2)$ represents one of the fundamental parameters of the Standard Model, and its precise determination is required a variety of phenomenological applications. We present an updated determination of $\alpha_s(m_Z)$ from the global NNPDF4.0 analysis carried out at approximated N^{3}LO (aN^{3}LO) accuracy, which also accounts for NLO QED corrections and the photon PDF, as well as for missing higher order uncertainties (MHOUs) for all processes considered. Our analysis is performed by means of two independent methodologies, the Correlated Replica Method and the Theory Covariance Method, yielding consistent results, and is extensively validated by closure tests where the underlying physical law is known. The latter provide the first closure test validation of $\alpha_s(m_Z)$ extractions from hadron collider data, and identify a number of potential pitfalls which may affect related determinations. In the baseline determination carried out at aN^{3}LO$_{\rm QCD} \otimes$ NLO$_{\rm QED}$ accuracy, we find $\alpha_s(m_Z) = 0.1194 \pm 0.0007$, consistent with the PDG average at the one-sigma level. We assess the perturbative convergence of our results, the role of QED corrections, the impact of MHOUs, and study their dependence on the input dataset. We also compare our determination with other recent extractions from PDF fits and from hadron collider data. Our result, with a total uncertainty of 0.6\%, provides one of the most precise determinations of the strong coupling obtained in the context of PDF fits.

Author: STEGEMAN, Roy

Presenter: STEGEMAN, Roy

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **74** Type: **not specified**

Neutrino results from the FASER experiment

Wednesday 26 March 2025 17:06 (22 minutes)

The FASER experiment at the LHC is designed to search for light, weakly-coupled new particles, and to study high-energy neutrinos. The experiment has been running since 2022, and has collected nearly 200/fb of pp collision data. FASER has released several neutrino results including the first observation of electron and muon neutrinos at a particle collider, the first measurement of the muon and electron neutrino interaction cross sections in the TeV energy range, and the first differential measurement with muon neutrinos and anti-neutrinos. This talk will summarise the FASER experiment, the neutrino results, and discuss future prospects for FASER neutrino results.

Author: BOYD, Jamie (CERN)

Presenter: BOYD, Jamie (CERN)

Session Classification: WG1/3: Joint session (WG1/3: Structure Functions and Parton Densities + Electroweak Physics and Beyond the Standard Model)

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **75** Type: **not specified**

The Forward Physics Facility at the HL-LHC

Tuesday 25 March 2025 14:22 (22 minutes)

The Forward Physics Facility (FPF) is a proposed new facility to house several far-forward experiments at the High Luminosity LHC at CERN. The FPF experiments will deetect more than a million neutrinos in the TeV energy range covering all neutrino flavours, as well as search for a host of new particles. The FPF has a broad physics programme covering BSM searches, neutrino physics, and QCD studies, with important implications for astroparticle physics. In terms of QCD studies, the FPF neutrino measurements will allow studies of proton structure both through DIS neutrino interactions in the target and from the production of neutrinos from far-forward charm decays. In addition, these measurements can shed light on intrinsic charm, BFKL dynamics, and the onset of gluon saturation. This talk will summarise the physics motivation for the FPF and give an overview of the status of studies on the facility and the proposed experiments.

Author: KRACK, Peter

Presenter: KRACK, Peter

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **76** Type: **not specified**

Combination of aN3LO PDFs and implications for Higgs production cross-sections at the LHC

Tuesday 25 March 2025 15:06 (22 minutes)

We discuss how the two existing approximate N3LO (aN3LO) sets of parton distributions (PDFs) from the MSHT20 and NNPDF4.0 series can be combined for LHC phenomenology, both in the pure QCD case and for the QCD⊗QED sets that include the photon PDF. Using the resulting combinations, we present predictions for the total inclusive cross-section for Higgs production in gluon fusion, vector boson fusion, and associated production at the LHC Run-3. For the gluon fusion and vector boson fusion channels, the corrections that arise when using correctly matched aN3LO PDFs with N3LO cross section calculations, compared to using NNLO PDFs, are significant, in many cases larger than the PDF uncertainty, and generally larger than the differences between the two aN3LO PDF sets entering the combination. The combined aN3LO PDF sets, MSHT20xNNPDF40_an3lo and MSHT20xNNPDF40_an3lo_qed, are made publicly available in the LHAPDF format and can be readily used for LHC phenomenology. We also demonstrate how the residual differences between the MSHT and NNPDF4.0 aN3LO fits are further reduced if the two groups adopt a common set of N3LO splitting function based on the most updated perturbative information.

Authors: ROJO CHACON, Juan (Nikhef National institute for subatomic physics (NL)); CRIDGE, Thomas (DESY)

Presenter: CRIDGE, Thomas (DESY)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **77** Type: **not specified**

sPHENIX measurement of neutral meson transverse single-spin asymmetry in high-statistics polarized p+p collisions

Tuesday 25 March 2025 11:00 (25 minutes)

The sPHENIX experiment is a next-generation collider detector at RHIC designed for rare jet and heavy-flavor probes of polarized p+p collisions. The experiment includes a large acceptance, granular electromagnetic calorimeter (EMCal) and very high-rate data acquisition plus trigger system. In RHIC Run-24, sPHENIX sampled 107/pb of transversely polarized p+p collision data at 200 GeV using an efficient high-p_T photon trigger, a dataset representing a nearly tenfold increase of the luminosity times acceptance compared to previous EMCal-based datasets for this collision energy. This talk presents measurements of the transverse single-spin asymmetry in inclusive production of neutral pions and eta mesons. Such an observable is sensitive to multi-parton correlations in the proton, which are related to transverse-momentum dependent (TMD) effects. The new sPHENIX data set allows significantly extending the kinematic range covered by previous RHIC mid-rapidity measurements.

Authors: ROSATI, Marzia; MAHAUT, Virgile (CEA Saclay)

Presenter: MAHAUT, Virgile (CEA Saclay)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **78** Type: **not specified**

Measurement of $\Lambda\bar{\Lambda}$ spin correlation in proton-proton collisions at STAR

Tuesday 25 March 2025 09:30 (25 minutes)

Approximately fifty years ago, the polarization of Λ hyperons produced in unpolarized proton-beryllium collisions was discovered, though the origin of this phenomenon remains elusive. Many studies indicate that final-state effects, particularly from hadronization, play a significant role. Recently, it has been proposed that spin correlations of Λ hyperons could provide insight into the underlying mechanisms of Λ polarization. In this talk, we report the first experimental measurements of $\Lambda\bar{\Lambda}$, $\Lambda\Lambda$, and $\bar{\Lambda}\bar{\Lambda}$ spin-spin correlations in p+p collisions at $\sqrt{s} = 200$ GeV, as recorded by the STAR experiment in 2012. Both short-range ($|\Delta y| < 0.5$ and $|\Delta\phi| < \pi/3$) and long-range ($0.5 < |\Delta y| < 2.0$, or $\pi/3 < |\Delta\phi| < \pi$) Λ hyperon pairs were measured. We will discuss the implications of the measured spin-spin correlations in relation to the longstanding puzzle of Λ hyperon polarization, offering new insights into the hadronization of strange quarks.

Author: VANEK, Jan (Brookhaven National Laboratory)

Co-author: TU, Zhoudunming

Presenter: TU, Zhoudunming

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **79** Type: **not specified**

A new TMD factorization for large and small x

QCD factorization takes on different forms in the large-x and the small-x regimes. In the large-x motivated collinear factorization, one gets the DGLAP evolution equation, whereas, in the small-x motivated rapidity factorization, the BFKL equation is the major player. To unify different regimes, a new TMD factorization based on the background field method is proposed, which not only reduces to CSS and DGLAP in the large-x limit and BFKL in the small-x limit, but also defines a general evolution away from these regimes. The calculations for gluon TMDs and quark TMDs are presented. Such a factorization has the potential to significantly advance our comprehension of high-energy processes and the three-dimensional structure of hadrons.

Authors: Dr TARASOV, Andrey (Post doctoral researcher); TIWARI, Shaswat (North Carolina State University); MUKHERJEE, Swagato; SKOKOV, Vladimir

Presenter: TIWARI, Shaswat (North Carolina State University)

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **80** Type: **not specified**

Progress on NNLO+PS predictions for top-quark pair production and decay

Wednesday 26 March 2025 11:00 (20 minutes)

In this presentation, I will discuss recent advancements in NNLO+PS predictions for top-quark pair production and decay within the MiNNLO framework. MiNNLO provides a robust method for incorporating next-to-next-to-leading order (NNLO) QCD corrections directly into fully differential predictions, offering unprecedented accuracy. This approach enables a consistent treatment of both production and decay processes, ensuring realistic event simulation compatible with experimental analyses. I will highlight the theoretical developments, key challenges, and the impact of these improvements on phenomenological studies, with a focus on their relevance to the increasing precision demands of LHC experiments.

Author: SIGNORILE , Chiara

Presenter: SIGNORILE , Chiara

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **82** Type: **not specified**

Prospects and challenges of a multi-TeV Muon Collider

Muon Collider is a unique machine that allows to achieve with a single facility both high energy reach and clean collision signature in a small environmental footprint. In particular, a collider with the centre-of-mass energy of 10 TeV is the long-term target of the ongoing international design study, while lower intermediate energies are also considered. Despite its much smaller size and lower energy consumption, the discovery potential of a 10-TeV Muon Collider would be comparable to that of the FCC-hh with its 100 TeV centre-of-mass energy.
A number of technological challenges must be overcome for making this project a reality, both at the accelerator, detector and computing sides. This contribution will provide an overview of the key technological aspects that set Muon Collider apart from other Future Collider experiments as well as potential synergies. It will also present the latest developments in each direction as part of preparation towards the next European Strategy for Particle Physics Update and the first demonstrator project.

Author: BARTOSIK, Nazar (UPO e INFN Torino (IT))

Presenter: BARTOSIK, Nazar (UPO e INFN Torino (IT))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **84** Type: **not specified**

Evaluating the Faithfulness of PDF uncertainties in the presence of Inconsistent Data

Wednesday 26 March 2025 11:00 (22 minutes)

In this talk we will critically assess the robustness of uncertainties on parton distribution functions (PDFs) determined using neural networks from global sets of experimental data collected from multiple experiments. The determination of PDFs is an inverse problem, and we study the way the neural network model tackles it when inconsistencies between input datasets are present. We use a closure test approach, in which the regression model is applied to artificial data produced from a known underlying truth, to which the output of the model can be compared and its accuracy can be assessed in a statistically reliable way. We explore various phenomenologically relevant scenarios in which inconsistencies arise due to incorrect estimation of correlated systematic uncertainties. We show that the neural network generally corrects for the inconsistency except in cases of extreme uncertainty underestimation, and we validate a previously proposed procedure to detect such extreme cases.

Author: UBIALI, Maria (University of Cambridge (GB))

Co-authors: BARONTINI, ANDREA (Università degli studi di Milano); DE CRESCENZO, Giovanni (University of Heidelberg); COSTANTINI, Mark; FORTE, Stefano (Università degli Studi e INFN Milano (IT))

Presenter: UBIALI, Maria (University of Cambridge (GB))

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **85** Type: **not specified**

Unravelling New Physics Signals at the HL-LHC with Low-Energy Constraints

Tuesday 25 March 2025 16:40 (20 minutes)

Recent studies suggest that global fits of Parton Distribution Functions (PDFs) might inadvertently 'fit away' signs of new physics in the high-energy tails of the distributions measured at the high luminosity programme of the LHC (HL-LHC). This could lead to spurious effects that might conceal key BSM signatures and hinder the success of indirect searches for new physics. In this talk, we demonstrate that future deep-inelastic scattering (DIS) measurements at the Electron-Ion Collider (EIC), and at CERN via FASER and SND@LHC at LHC Run III, and the future neutrino experiments to be hosted at the proposed Forward Physics Facility (FPF) at the HL-LHC, provide complementary constraints on large-x sea quarks. These constraints are crucial to mitigate the risk of missing key BSM signals, by enabling precise constraints on large-x PDFs through a 'BSM-safe' integration of both high- and low-energy data, which is essential for a robust interpretation of the high-energy measurements.

Author: UBIALI, Maria (University of Cambridge (GB))

Co-author: HAMMOU, Elie

Presenter: UBIALI, Maria (University of Cambridge (GB))

Session Classification: WG1/6: Joint session (WG1/6: Structure Functions and Parton Densities + Future Experiment)

Track Classification: Structure Functions and Parton Densities

Contribution ID: **86** Type: **not specified**

Inferring the initial condition for the BK evolution at next-to-leading order accuracy

We promote our leading order analysis [1] determining the initial condition of the Balitsky-Kovchegov (BK) evolution equation to the next-to-leading order treatment, using both the NLO BK equation and NLO impact factors. The initial condition, to be described by the posterior distribution obtained via Bayesian optimization, is constrained by the total cross section and charm quark production measurements from HERA. The determined posterior distribution [2] is a necessary input for all NLO calculations in the CGC framework, and enables one to rigorously propagate uncertainties from this non-perturbative input to calculated cross sections. The HERA data are found to provide tight constraints for the initial condition. A successful description of all HERA data is obtained only with initial condition parametrizations that feature a steep dipole-target scattering amplitude at moderately small dipoles.

References:
[1] Casuga, C., Karhunen, M., Mäntysaari, H., Phys.Rev.D 109 (2024) 054018 arXiv: 2311.10491.
[2] Casuga, C., Hänninen, H., Mäntysaari, H., in preparation

Authors: CASUGA, Carlisle Aurabelle (University of Jyväskylä); Dr MÄNTYSAARI, Heikki (University of Jyväskylä); HÄNNINEN, Henri (University of Jyväskylä)

Presenter: CASUGA, Carlisle Aurabelle (University of Jyväskylä)

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **87** Type: **not specified**

NLO event generation of neutrino DIS at FASER and application to neutrino flux measurements

Tuesday 25 March 2025 09:22 (22 minutes)

The LHC generates a beam of high-energy neutrinos in the forward direction, whose scientific potential has been ignored in the past. The FASERv and SND@LHC experiments have recently measured signals from these LHC neutrinos for the first time. To produce accurate predictions including NLO QCD corrections for FASERν and SND@LHC and the planned experiments at the proposed Forward Physics Facility (FPF) such as FASERν2 and FLArE, the energy and rapidity distribution of the LHC neutrinos can be encoded in a LHAPDF grid and be used in the neutrino DIS event generator implemented in the POWHEG-BOX-RES framework, that has recently become available. Such a Monte Carlo tool, interfaced with the Pythia8 parton shower, is essential to model differential distributions that are sensitive to hadronic final states and to account for realistic acceptance cuts. Furthermore, this event generator can be modified to compute fast-interpolation tables, that are a crucial ingredient to perform fits of the neutrino flux: The problem of determining the neutrino flux is formally equivalent to the determination of parton distribution functions. Therefore, the NNPDF fitting methodology can be adapted to parametrise the neutrino flux by a neural network and extract the flux from measurements in a theory-agnostic manner.

Author: KRACK, Peter

Presenter: KRACK, Peter

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **88** Type: **not specified**

Transverse Single Spin Asymmetry of Electromagnetic Jets at Forward Rapidity in p↑+p Collisions at STAR

Wednesday 26 March 2025 11:50 (25 minutes)

One of the big challenges facing proton spin structure is the unexpectedly large transverse single spin asymmetries (TSSA, A_N) in transversely polarized $p^{\uparrow} + p$ collisions. Significant non-zero TSSAs in inclusive hadron productions at forward rapidities have been observed in many experiments, including those at RHIC. Despite extensive theoretical efforts, including twist-3 contributions within collinear factorization and transverse momentum-dependent (TMD) frameworks, no theory has been able to fully explain the observed phenomena. Recent measurements from the STAR experiment suggested that diffractive processes may also contribute to the observed TSSAs, providing the motivation for this study.

This talk will present measurements of electromagnetic-jet A_N for inclusive and single diffractive processes in $p^{\uparrow} + p$ collisions at $\sqrt{s}$ = 200 and 510 GeV. Preliminary results for A_N at $\sqrt{s}$ = 200 GeV will be discussed, with a focus on the contribution of the single diffractive process to the overall inclusive A_N. Furthermore, the current status of the analysis for both inclusive and single diffractive processes at $\sqrt{s}$ = 510 GeV at STAR will be presented. These studies aim to shed light on the underlying mechanisms driving the large TSSA.

Author: ZHANG, Weibin

Presenter: ZHANG, Weibin

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **89** Type: **not specified**

An overview of the test station involved in the production of the LVPS for the Phase II upgrade of the Tile Calorimeter.

The Phase II upgrade at CERN represents a significant advancement in preparing for the High Luminosity Large Hadron Collider (HL-LHC) era. This upgrade includes substantial enhancements to the detector systems, particularly the integration of radiation-resistant transformer-coupled buck converters, referred to as LVPS bricks. A thorough quality assurance process is being implemented to improve the reliability of the Low-Voltage Power Supply (LVPS) bricks within the ATLAS Hadronic Tile-Calorimeter (TileCal). In partnership with the University of the Witwatersrand and iThemba LABS, more than a thousand LVPS bricks will be developed. These bricks are essential for converting 200V direct current (DC) power into the 10V DC power needed for detector operation. Extensive initial testing of these bricks is critical to ensure their reliability and performance under the challenging conditions anticipated in the HL-LHC era, including high radiation levels, increased trigger rates, and substantial pile-up. The next phase will involve gathering and analyzing test data using advanced machine learning techniques. This data-driven approach will offer deeper insights into the bricks' behavior under extreme conditions, enabling the optimization of their design and performance to meet the demanding requirements of the HL-LHC upgrade.

Author: Mr CHABALALA, Vongani Cyril (University of the Witwatersrand (ZA))

Co-authors: MELLADO GARCIA, Bruce (University of the Witwatersrand); MCKENZIE, Ryan Peter (University of the Witwatersrand (ZA)); PILUSA, Thabo (University of the Witwatersrand (ZA))

Presenter: Mr CHABALALA, Vongani Cyril (University of the Witwatersrand (ZA))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **90** Type: **not specified**

NNPDFpol2.0: a first global determination of polarised PDFs at NNLO accuracy with theory uncertainties

Tuesday 25 March 2025 09:55 (25 minutes)

We present NNPDFpol2.0, a new set of polarised parton distribution functions (PDFs) of the proton based on legacy measurements of structure functions in inclusive polarised deep-inelastic scattering (DIS), and of W-boson, single-inclusive, and di-jet production asymmetries in polarised proton-proton collisions. The determination is accurate to next-to-next-to-leading order in the strong coupling, and specifically includes heavy quark mass corrections in the analysis of DIS data. Uncertainties due to missing higher-order corrections are systematically incorporated by means of a covariance matrix determined by scale variations. NNPDFpol2.0 is based on a machine learning methodology, that makes use of Monte Carlo sampling for the representation of uncertainties into PDFs, of a neural network for the parametrisation of PDFs, of stochastic gradient descent for the optimisation of PDF parameters, and of hyperoptimisation for the selection of the best fitting model. We study the impact on PDFs of the data, of higher-order corrections, and of theoretical constraints. We assess the phenomenological implications of NNPDFpol2.0, specifically concerning the determination of the proton spin fraction carried by quarks and gluons, and the description of single-hadron production in polarised DIS and proton-proton collisions.

Author: Dr RABEMANANJARA, Tanjona R. (NIKHEF & VU Amsterdam)

Presenter: Dr RABEMANANJARA, Tanjona R. (NIKHEF & VU Amsterdam)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **91** Type: **not specified**

NNPDF updates and the path toward NNPDF4.1: data, theory, and methodology

Tuesday 25 March 2025 12:16 (22 minutes)

We report on recent advancements in the global determination of the unpolarised proton PDFs by the NNPDF collaboration. Since the previous major release, several improvements have been made in both theoretical frameworks and methodological approaches, supplemented with high-statistic measurements from LHC Run II. On the theoretical front, we present the current state-of-the-art PDF determination which is accurate at aN3LO and includes a photon PDF with an estimate of the missing higher-order uncertainties (MHOUs). Methodologically, we introduce a novel strategy for the automated determination of the hyperparameters in neural network models based on statistical estimators constructed from an ensemble of models sampling the underlying PDF distribution in model space. We demonstrate the effectiveness of this strategy using modern hardware accelerators and assess the robustness of the resulting uncertainty estimates in comparison with the NNPDF4.0. Finally, on the data side, we evaluate the performance of global PDF fits by confronting them with high-precision LHC data, employing state-of-the-art theoretical predictions. We quantify the goodness-of-fit, considering all sources of experimental and theoretical uncertainties, and provide an objective criterion to decide which PDF sets should be used to interpret available and future measurements.

Author: Dr RABEMANANJARA, Tanjona R. (NIKHEF & VU Amsterdam)

Presenter: Dr RABEMANANJARA, Tanjona R. (NIKHEF & VU Amsterdam)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **92** Type: **not specified**

COMPASS, AMBER and LHCspin Fixed Target Experiments at CERN: Highlights for TMD Measurements Today and in the Future

Tuesday 25 March 2025 09:00 (30 minutes)

COMPASS is currently the longest-running experiment at CERN, having collected physics data for a record-breaking 20 years from 2002 to 2022. The experiment has a unique and diverse physics program focused on nucleon structure and spectroscopy measurements.
The experimental results obtained by COMPASS during its two phases (2002-2011 and 2012-2022, respectively) for a wide range of quark transverse momentum dependent DIS and Drell-Yan measurements play an essential role in the general understanding of the three-dimensional nature of the nucleon. In 2022, the experiment performed its final highly successful data taking dedicated to the study of TMD phenomena in semi-inclusive measurements of hadron production in DIS using a high energy muon beam and a transversely polarized deuteron target.

This talk will provide a comprehensive review of recent advancements in COMPASS nucleon spin structure studies and will offer insights into future prospects.

Author: Dr PARSAMYAN, Bakur (AANL, Turin section of INFN and CERN)

Presenter: Dr PARSAMYAN, Bakur (AANL, Turin section of INFN and CERN)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **93** Type: **not specified**

A Neural-Network Extraction of Unpolarized Transverse-Momentum Distributions

Wednesday 26 March 2025 11:25 (25 minutes)

We present the first proof of concept extraction using neural networks (NNs) of the unpolarised transverse-momentum distributions (TMDs) at next-to-next-to-next-to-leading logarithmic(N^3LL) accuracy. By offering a more flexible and adaptable approach, NNs overcome some of the limitations of traditional functional forms, providing a better description of data. This work focuses exclusively on Drell-Yan (DY) data and establishes the feasibility of NN-based TMD extractions.

Authors: Prof. BACCHETTA, Alessandro; BISSOLOTTI, Chiara (Argonne National Laboratory); RADICI, Marco; CERUTTI, Matteo (Christopher Newport University and Jefferson Lab); RODINI, Simone (University of Regensburg); Dr BERTONE, Valerio (C.E.A. Paris-Saclay)

Presenter: BISSOLOTTI, Chiara (Argonne National Laboratory)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **94** Type: **not specified**

News from the CTEQ-TEA global analysis

Tuesday 25 March 2025 11:54 (22 minutes)

We summarize latest developments in the CTEQ-TEA global QCD analysis of parton distributions in the nucleon.

Authors: COURTOY, Aurore (Instituto de Física, UNAM); YUAN, C.-P. (Michigan State University); HUSTON, Joey (Michigan State University (US)); XIE, Keping (Michigan State University); GUZZI, Marco (Kennesaw State University); Prof. NADOLSKY, Pavel (Michigan State University); DULAT, Sayip; Dr HOBBS, TIMOTHY J (Argonne National Laboratory)

Presenter: Dr HOBBS, TIMOTHY J (Argonne National Laboratory)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **95** Type: **not specified**

Fantômas: advanced polynomial parametrizations for parton distributions

Wednesday 26 March 2025 09:44 (22 minutes)

Fantômas is a C++ module implemented in xFitter for universal approximation of parton densities and other quantum correlator functions using Bézier curves. We review its operating principles and an application of the Fantômas framework to obtain parton distributions in a charged pion with detailed estimates of parametrization and nuclear uncertainties.

Authors: COURTOY, Aurore (Instituto de Física, UNAM); KOTZ, Lucas; PONCE CHAVEZ, Max; Dr HOBBS, TIMOTHY J (Argonne National Laboratory); Prof. OLNESS, Fred (Southern Methodist University (US)); Prof. NADOLSKY, Pavel (Michigan State University)

Presenters: COURTOY, Aurore (Instituto de Física, UNAM); Dr HOBBS, TIMOTHY J (Argonne National Laboratory); Prof. OLNESS, Fred (Southern Methodist University (US))

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **96** Type: **not specified**

Spin asymmetries and cross sections of eta mesons at PHENIX

Tuesday 25 March 2025 14:25 (25 minutes)

Recent measurements by the PHENIX collaboration of η meson spin observables will be presented. The η meson is a practical final-state for study: as a light neutral meson, it is abundantly produced in hadronic collisions, while its heavier mass compared to the π^0 helps mitigate detector effects that limit the reach and precision of its lighter counterpart. At forward rapidity, the cross section at $\sqrt{s} = 500$ GeV and transverse single spin asymmetry (TSSA) at $\sqrt{s} = 200$ GeV were measured. For p_T
$gtrsim2$ GeV, the cross section is well-described by perturbative QCD calculations, confirming collinear factorization in this regime. This measurement is set to be included in an updated η meson fragmentation function global analysis. The forward TSSA provides sensitivity to the twist-3 quark-gluon correlation functions, related by k_T moments to the quark transverse-momentum-dependent distributions. At high Feynman-x values, large asymmetries exceeding 30% are observed. Comparisons to the π^0 TSSA indicate no major impact from final-state differences like mass or strange quark content. On the other hand, predictions of the twist-3 initial-state contribution to the TSSA underestimate the asymmetry, suggesting a key role played by twist-3 fragmentation terms. The status of the midrapidity cross section and longitudinal double spin asymmetry at $\sqrt{s} = 510$ GeV will also be presented. These measurements have the broadest reach in p_T of any PHENIX inclusive measurement. The cross section will serve as an additional input to the global fragmentation function fit while the longitudinal spin asymmetry probes the gluon helicity distribution.

Author: LOOMIS, Devon (University of Michigan)

Presenter: LOOMIS, Devon (University of Michigan)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **97** Type: **not specified**

T-odd and T-even hadronic structures of the Drell-Yan process. Small Q_T/Q expansion

Tuesday 25 March 2025 14:50 (25 minutes)

We present detailed analysis of the T-even and T-odd lepton angular distribution in the Drell-Yan process including γ/Zˆ0 gauge boson exchange and using perturbative QCD based on the collinear factorization scheme at leading order in the α_s expansion and α_sˆ2 for T-odd . We focus on the study of the transverse momentum Q_T dependence of the corresponding hadronic structure functions and angular coefficients up to next-to-next-to-leading order in the Q_Tˆ2/Qˆ2 expansion. We analyze Q_T dependence numerically and compare T-even angular coefficients with available data of the ATLAS Collaboration at LHC.

Author: ZHEVLAKOV, Alexey (Joint Institute for Nuclear Research (RU))

Presenter: ZHEVLAKOV, Alexey (Joint Institute for Nuclear Research (RU))

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **98** Type: **not specified**

The study for search of dark matter physics on fixed target experiments.

Tuesday 25 March 2025 16:40 (20 minutes)

Fixed target experiments are excellent tools for searching for signals of weak interacting dark matter in the sub-GeV mass region. The concept of dark portals between hidden and ordinary matter, as described by the Standard Model, typically involves light sub-GeV intermediate states. In particular, the dark photon portal will be considered and discussed within the framework of existing and future experiments, such as NA64 and NA62 at the SPS at CERN. In beam dump mode such experiments are also tools for studying visible modes of dark matter. We will discuss the current experimental situation, our theoretical calculation of dark photon production and discuss general model of dark photon limits in the sub-GeV mass region.

Author: ZHEVLAKOV, Alexey (Joint Institute for Nuclear Research (RU))

Presenter: ZHEVLAKOV, Alexey (Joint Institute for Nuclear Research (RU))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **99** Type: **not specified**

Measuring the anomalous $t\bar{t}Z$ couplings in future $e^{-}p$ colliders.

Thursday 27 March 2025 09:50 (20 minutes)

We investigate the anomalous $t\bar{t}Z$ couplings in the Standard Model (SM) and measure the precision of couplings beyond the SM in future electron-proton collider environments. In the analysis, $t\bar{t}$ quark pairs are produced in the neutral currents channel through the collision process $e^{-}p \to e^{-}t\bar{t}$, for electron and proton (unpolarized) beam-energies $E_e = 60$ GeV and $E_p = 7$ TeV respectively, at a combined center-of-mass energy of 1.3 TeV as proposed for the Large Hadron-electron Collider. Each of the top quarks in the $t\bar{t}$ pair can decay through the leptonic or the hadronic mode resulting in either the leptonic, hadronic, or semileptonic final states. Sensitive angular observables are utilized to measure and constrain the $t\bar{t}Z$ couplings. We find that the azimuthal angle difference, $\Delta\phi$, between the top quarks decay products, and that of each top quark with the scattered electron in the semileptonic final state are most sensitive and viable angular observable for constraining the couplings. We perform a χ^2 analysis based on the azimuthal difference to constrain the couplings.

Author: MACHETHE, Katlego

Co-author: KUMAR, Mukesh (University of the Witwatersrand (ZA))

Presenter: MACHETHE, Katlego

Session Classification: WG3/6: Joint session

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **100** Type: **not specified**

Heavy Quark Contributions to Deep Inelastic Structure Functions F4 and F5

Tuesday 25 March 2025 16:20 (20 minutes)

This work presents the next-to-leading order calculation of the heavy quark production contributions to the structure functions F4 and F5 within the ACOT formalism in deep inelastic scattering. These struc ture functions have been largely overlooked in the past, mainly due to the experimental challenges associated with their measurement. How ever, forthcoming experimental advancements, such as the planned SHiP experiment, may provide new opportunities for their measurements

Authors: SPEZZANO, Edoardo; SCHIENBEIN, Ingo (Universite Grenoble Alpes); KLASEN, Michael; Dr RISSE, Peter (Southern Methodist University); JEZO, Tomas (WWU ITP)

Presenter: SPEZZANO, Edoardo

Session Classification: WG1/6: Joint session (WG1/6: Structure Functions and Parton Densities + Future Experiment)

Track Classification: Structure Functions and Parton Densities

Contribution ID: **101** Type: **not specified**

Positive-definite gluon fragmentation into quarkonia

Tuesday 25 March 2025 14:00 (20 minutes)

We revisit the fragmentation processes $g \to \chi_{cJ} + g$, $g \to \eta_c + g$, $g \to J/\psi + g + g$ and propose and alternative method to regularize the infrared and collinear divergencies. We argue that the conventional technique (i.e., the dimensional regularization) are unphysical, as they expand the perturbation theory beyond its applicability limits. At the same time, the conventional calculations ignore some important physical phenomena, such the finite size of the quarkonium bound states and the presence of confinement. The latter ones can take credit for a physical rather than mathematical reasoning for the regularization. We propose a simple semi-phenomenological method that restores the physical behavior of all fragmentation functions making them positive-definite, smooth, and vanishing at the endpoints D(z=1) = D(z=0) = 0.

Author: BARANOV, Sergey (P.N.Lebedev Physical Institute, Moscow)

Presenter: BARANOV, Sergey (P.N.Lebedev Physical Institute, Moscow)

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **102** Type: **not specified**

Automatic differentiation for Balitsky-Kovchegov equation

We present an implementation of the Balitsky-Kovchegov (BK) evolution equation solver using differentiable programming. First and second derivatives of the amplitude with respect to the initial condition parameters are automatically calculated at all stages of the simulation. This should considerably facilitate and speed up the procedure of fitting initial condition parameters to data. Moreover, in the context of Transverse Momentum Distributions (TMD), we demonstrate that automatic differentiation can be used to obtain derivatives of the amplitude with respect to the quark-antiquark separation with better precision than the finite difference method.

Authors: COUGOULIC, Florian; KORCYL, Piotr (Jagiellonian University); STEBEL, Tomasz (Institute of Theoretical Physics Jagiellonian University)

Presenter: STEBEL, Tomasz (Institute of Theoretical Physics Jagiellonian University)

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **103** Type: **not specified**

DVCS on longitudinally polarised proton with the CLAS12 experiment at JLab.

Tuesday 25 March 2025 11:50 (25 minutes)

Measuring Deeply Virtual Compton Scattering (DVCS) observables offers the most direct access to Generalised Parton Distributions (GPDs), which offer a 3D description of the quark and gluon distributions in position and momentum inside the nucleon. GPDs are essential to understand how the nucleon's global properties, such as its spin and mass, arise from quarks and gluons.
The extraction of GPDs requires high precision measurements of multiple observables across a broad kinematic range. Measurements in all electron and proton spin configurations is also necessary in order to disentangle contributions from polarised and unpolarised GPDs.
The CLAS12 experiment at JLab can explore a wide phase space in the valence region with high statistics thanks to the upgraded CEBAF 10.5 GeV polarised electron beam. CLAS12 has recently taken data for the first time with a longitudinally polarised nucleon target, opening the possibility to measure DVCS observables on polarised proton over a new kinematic space.
I will report on preliminary measurements of DVCS target and double spin asymmetries from the first longitudinally polarised proton target experiment at CLAS12.

Author: POLCHER RAFAEL, Samy (CEA Saclay - Université Paris Saclay)

Presenter: POLCHER RAFAEL, Samy (CEA Saclay - Université Paris Saclay)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **104** Type: **not specified**

nCTEQ global analysis of nuclear PDFs

Wednesday 26 March 2025 14:00 (22 minutes)

We present a new global analysis of nuclear PDFs in the nCTEQ approach. Building on a modern proton baseline without nuclear data and extending the kinematic range, we combine and update previous separate analyses that focused on JLab neutral-current DIS, neutrino DIS and dimuon production, and the currently available LHC data, in particular on W/Z-boson and heavy-quark production. For the latter, we not only employ a data-driven approach, but also perform an alternative fit based on NLO QCD and the ACOT variable flavor number scheme. As a result, we obtain PDFs with reduced uncertainties in both the high-x and low-x regimes, in particular for the gluon and the strange quark. We also present predictions for observables that were not included in this analysis.

Authors: KUSINA, Aleksander; Prof. OLNESS, Fred (Southern Methodist University (US)); SCHIENBEIN, Ingo (Universite Grenoble Alpes); KOVARIK, Karol; KLASEN, Michael; JEZO, Tomas (WWU ITP)

Presenter: KLASEN, Michael

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **105** Type: **not specified**

Perturbative RGE systematics in precision observables

Tuesday 25 March 2025 09:00 (22 minutes)

In this talk, I will show how ambiguities related to solutions of renormalisation group equations (RGEs) can contribute significantly to systematic uncertainties of theoretical predictions for physical observables. I will discuss a general method to estimate these systematic effects using techniques inspired by soft-gluon and transverse-momentum resummation approaches. As application cases, I will consider the evolution of strong coupling, collinear parton-distribution functions (PDFs), and transverse-momentum-dependent distributions (TMDs). Finally, I will present the implications for precision observables in hadron-collider processes.

Author: Dr BERTONE, Valerio (C.E.A. Paris-Saclay)

Co-authors: HAUTMANN, Francesco (Institute of Theoretical Physics); BOZZI, Giuseppe (University of Cagliari and INFN, Cagliari)

Presenter: Dr BERTONE, Valerio (C.E.A. Paris-Saclay)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **108** Type: **not specified**

DIS dijet production at next-to-eikonal order

One of the main approximations adopted in the Color Glass Condensate (CGC) is the so-called eikonal approximation, which amounts to neglecting power-suppressed corrections in the high-energy limit. This approximation is well justified for asymptotically high energies. However, the corrections to it might be sizable in the upcoming Electron Ion Collider. The next-to-eikonal order cross-section of inclusive dijet production in deep inelastic scattering at low x in the dipole formalism consists of decorated dipoles and quadrupoles of Wilson lines. For numerical studies of CGC at eikonal order, the McLerran-Venugopalan (MV) model is well established. However, to study dijets in DIS at next-to-eikonal order numerically, we have to extend MV model to include these new dipoles and quadrupoles. Specifically, we incorporate next-to-eikonal corrections coming due to the finite width of the target and contributions coming due to the transverse components of the gluon background field. I will present the details of extending the MV model to next-to-eikonal order.

Authors: Dr BEUF, Guillaume (NCBJ, Poland); Prof. ARMESTO, Nestor (IGFAE, Spain); Dr AGOSTINI, Pedro (NCBJ, Poland and IGFAE, Spain.); MULANI, Swaleha (National Centre for Nuclear Research(NCBJ), Warsaw, Poland); Dr ALTINOLUK, Tolga (NCBJ, Poland)

Presenter: MULANI, Swaleha (National Centre for Nuclear Research(NCBJ), Warsaw, Poland)

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **109** Type: **not specified**

Axion-Like Particles: From Explaining Muon g-2 and Relic Abundance to Collider Aspects

Thursday 27 March 2025 09:30 (20 minutes)

We address long-standing problems in the muon anomalous magnetic moment, the observed relic density, and the recent measurements by the CMS and ATLAS collaborations of the Higgs decay signal strength in h⟶Zγ using a common framework. This framework incorporates the coupling of axion-like particles (ALPs) with charged leptons and electroweak gauge bosons. In this talk, we will present bounds on these couplings from the muon g−2 anomaly and demonstrate the feasibility of these bounds in satisfying relic abundance in dark matter annihilation via the ALP portal. Finally, I will present the bounds on the coupling of ALPs with electroweak gauge bosons from signal strength measurements in h⟶Zγ decay and future ep and e+e− collider scenarios.

Authors: Prof. GOYAL, Ashok (University of Delhi); Dr KUMAR, Mukesh (University of the Witwatersrand, Johannesburg); SHARMA, Pramod; Mr SINGH, Soham (National Institute of Technology, Rourkela)

Presenters: Dr KUMAR, Mukesh (University of the Witwatersrand, Johannesburg); SHARMA, Pramod; Mr SINGH, Soham (National Institute of Technology, Rourkela)

Session Classification: WG3/6: Joint session

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **110** Type: **not specified**

Effective LFV couplings at the electron-proton collider

Thursday 27 March 2025 09:10 (20 minutes)

We estimate the accuracy with which the coefficient of the lepton flavour-violating dimension-six operators can be measured at the proposed electron-proton collider.
Cuts-based analysis is performed to compute the signal significance at the centre of mass energy of 1.3 TeV, with a total of 3 ab^{-1} integrated luminosity. Using the optimal observables method for the kinematic distributions, we study the sensitivity of the effective couplings. We also study the impact of the initial electron beam polarisation.

Author: BHARADWAJ, Hrishabh

Co-author: Prof. DUTTA, Sukanta (SGTB Khalsa College, University of Delhi and Delhi School of Analytics, University of Delhi)

Presenter: BHARADWAJ, Hrishabh

Session Classification: WG3/6: Joint session

Track Classification: Future Experiments

Contribution ID: **111** Type: **not specified**

Precise Determination of the Strong Coupling Constant from Dijet Cross Sections up to the Multi-TeV Range

Thursday 27 March 2025 09:44 (20 minutes)

We determine the value of the strong coupling α_s and study its running over a wide range of scales as probed by the dijet production process at hadron colliders. The analysis is performed using the complete next-to-next-to-leading order (NNLO) predictions in perturbative QCD and is based on dijet data published by ATLAS and CMS at center-of-mass energies of 7, 8, and 13 TeV. From a large subset of these data we infer a value of α_s(m_Z)=0.1178±0.0022 for the strong coupling at the scale of the Z-boson mass m_Z.
Complementing the LHC data with dijet cross sections measured at HERA, we extend the range to test the predicted running of the strong coupling towards smaller scales. Our results exhibit excellent agreement with predictions based on the renormalization group equation of QCD. This study represents the a very comprehensive test of the asymptotic behaviour of QCD, spanning over three orders of magnitude in energy scale from 7GeV up to 7TeV. (work based on arXiv:2412.21165)

Authors: HUSS, Alexander Yohei (CERN); GEHRMANN-DE RIDDER, Aude (ETH Zurich); GWENLAN, Claire (University of Oxford (GB)); BRITZGER, Daniel (Max-Planck-Institut für Physik München); GLOVER, EDWARD,WILLIAM,NIGEL; HEINRICH, Gudrun (KIT); Dr RAMALHO PIRES, Joao (LIP, Instituto Superior Tecnico, Universidade de Lisboa); RABBERTZ, Klaus (KIT - Karlsruhe Institute of Technology (DE)); SUTTON, Mark (University of Sussex (GB)); GEHRMANN, Thomas Kurt (University of Zurich (CH)); Dr CHEN, Xuan (Shandong University)

Presenter: GWENLAN, Claire (University of Oxford (GB))

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **112** Type: **not specified**

Anomalous electroweak physics unraveled via evidential deep learning

Wednesday 26 March 2025 16:44 (22 minutes)

The ever-growing ecosystem of beyond standard model (BSM) calculations and parametrizations has motivated the development of systematic methods for making quantitative cross-comparisons over the wide range of possible models, especially with controllable uncertainties. In this talk, we highlight how the language of uncertainty quantification (UQ) furnishes useful metrics for assessing statistical overlaps and discrepancies among BSM and related models. We leverage recent machine learning (ML) developments in evidential deep learning (EDL) for UQ to separate data (aleatoric) and knowledge (epistemic) uncertainties in a model-discrimination setting. We construct several potentially BSM-motivated scenarios for the anomalous electroweak interaction (AEWI) of neutrinos with nucleons in deep inelastic scattering (νDIS) and quantitatively map these as a demonstration alongside Monte Carlo replicas of the CT18 PDFs used to calculate the $\Delta\chi^2$ statistic for a typical multi-GeV νDIS experiment, CDHSW. This approach can help facilitate efficient BSM model exploration and exclusion for future New Physics searches while complementing a suite of related ML-based PDF analysis tools, which we also highlight.

Authors: KRIESTEN, Brandon; Dr HOBBS, TIMOTHY J (Argonne National Laboratory)

Presenter: Dr HOBBS, TIMOTHY J (Argonne National Laboratory)

Session Classification: WG1/3: Joint session (WG1/3: Structure Functions and Parton Densities + Electroweak Physics and Beyond the Standard Model)

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **113** Type: **not specified**

Parton density and fragmentation functions in QED

Wednesday 26 March 2025 16:00 (22 minutes)

Perturbative solutions for unpolarized QED parton distribution and fragmentation functions are presented explicitly in the next-to-leading logarithmic approximation. The scheme of iterative solution of QED evolution equations is described in detail. Applications of the QED PDFs and fragmentation functions for calculation of higher-order radiative corrections to processes of electron-positron annihilation and muon decay are given. Effects of scheme and factorization scale choice are analyzed.
The talk is based on
[1] A.B. Arbuzov, U.E. Voznaya, J. Phys. G 50 (2023) 12, 125004;
[2] A.B. Arbuzov, U.E. Voznaya, Phys. Rev. D 109 (2024) 5, 053001;
[3] A.B. Arbuzov, U.E. Voznaya, Phys. Rev. D 109 (2024) 11, 113002;
and some recent developments in this direction.

Author: ARBUZOV, Andrej (Joint Institute for Nuclear Research)

Co-author: Mrs VOZNAYA, Uliana (Joint Institute for Nuclear Research)

Presenter: ARBUZOV, Andrej (Joint Institute for Nuclear Research)

Session Classification: WG1/3: Joint session (WG1/3: Structure Functions and Parton Densities + Electroweak Physics and Beyond the Standard Model)

Track Classification: Structure Functions and Parton Densities

Contribution ID: **114** Type: **not specified**

Growing Signature of a Narrow Resonance at 152 GeV

Tuesday 25 March 2025 17:00 (20 minutes)

The Higgs boson discovery at the Large Hadron Collider (LHC) completed the Standard Model (SM). Still, the possibility of additional scalar bosons remains open, provided their contributions to electroweak symmetry breaking are sufficiently small. Recent analyses of LHC data have revealed statistically significant anomalies in multi-lepton final states, characterized by events with multiple leptons, missing transverse energy, and jets. These anomalies provide intriguing hints of physics beyond the SM.

In this work, we present the signature of growing excesses for a new scalar resonance with a mass of \(152 $\pm$ 1\) GeV, observed in the $\gamma\gamma$, Zγ\, and WW channels. The combined global significance reaches a level that points toward the growing signature of this resonance. The findings align with a simplified model in which a heavy scalar boson decays into two lighter scalars, providing a consistent explanation for the observed multi-lepton anomalies.

These results significantly advance the search for new scalar bosons at the electroweak scale. Future investigations, including precision studies with upcoming HL-LHC data, will be crucial for confirming the nature of this resonance and exploring its implications for extending the SM.

Author: BHATTACHARYA, Srimoy

Co-authors: MELLADO GARCIA, Bruce (University of the Witwatersrand); KUMAR, Mukesh (University of the Witwatersrand (ZA)); Dr MAZINI, Rachid (University of the Witwatersrand, Johannesburg)

Presenter: BHATTACHARYA, Srimoy

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **115** Type: **not specified**

Discovery Potential of Future Electron-Positron Colliders for a 95 GeV Scalar

Thursday 27 March 2025 10:10 (20 minutes)

The observed indications of a new scalar resonance around 95 GeV, initially reported by LEP and supported by CMS and ATLAS in di-photon, $\tau\tau$, and W^+W^- channels, motivate exploring its discovery potential at future electron-positron colliders. This study focuses on the production of the new scalar (S) in $e^+e^- \to ZS$ process with $Z \to \mu^+\mu^-$ and $S \to b\bar{b}$ and optimize the signal using the recoil-mass method. By employing deep neural networks for signal-background discrimination, we demonstrate that a 95 GeV scalar, mixing with the Standard Model Higgs by an angle of ~ 0.1, can be observed with 5σ significance at $\sqrt{s} = 250$ GeV and 200 GeV for 5 ab^{-1} of integrated luminosity.

Authors: Dr CRIVELLIN, Andreas (Paul Scherrer Institut, Villigen); Prof. MELLADO, Bruce (niversity of the Witwatersrand, Johannesburg,); Dr KUMAR, Mukesh (University of the Witwatersrand, Johannesburg); SHARMA, Pramod

Presenters: Dr CRIVELLIN, Andreas (Paul Scherrer Institut, Villigen); Dr KUMAR, Mukesh (University of the Witwatersrand, Johannesburg); SHARMA, Pramod

Session Classification: WG3/6: Joint session

Track Classification: Future Experiments

Contribution ID: **117** Type: **not specified**

The LHeC empowering the HL-LHC program

Wednesday 26 March 2025 16:00 (22 minutes)

The Large Hadron electron Collider is a proposed upgrade of the HL-LHC. It will add an energy recovery racetrack to the CERN accelerator complex. The ERL will provide 50 GeV electrons to collide with the LHC beams, resulting in ep (eA) collisions with cms energies $\sim 1.2(0.75)$ TeV/nucleon and instantaneous luminosities $\sim 10^{34}(5 \cdot 10^{32})$ cm^{-2}s^{-1}. It could be built to start operation after the HL-LHC, and deliver integrated ep luminosities around 1 ab^{-1}, serving as a bridge between the LHC and the next flagship project at CERN. After a brief introduction to the accelerator and detector, in this contribution we show how the LHeC will empower the HL-LHC program by providing physics input, prominently PDFs and α_s, needed for reduce uncertainties in measurements, such us in determinations of M_W, $\sin^2\theta_W$ or the Higgs cross section and mass, and for enlarging the reach for searches.

Author: ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))

Presenter: ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **118** Type: **not specified**

The physics program of high-energy DIS: LHeC and FCC-eh

Tuesday 25 March 2025 14:00 (22 minutes)

The Large Hadron electron Collider is a proposed upgrade of the HL-LHC. It will add an energy recovery racetrack to the CERN accelerator complex. The ERL will provide 50 GeV electrons to collide with the LHC beams, resulting in ep (eA) collisions with cms energies $\sim 1.2(0.75)$ TeV/nucleon and instantaneous luminosities $\sim 10^{34}$ $(5 \cdot 10^{32})$ cm^{-2}s^{-1}. It could be built to start operation after the HL-LHC, and deliver integrated ep luminosities around 1 ab^{-1}, serving as a bridge between the LHC and the next flagship project at CERN. If the ERL is added to the FCC, FCC-eh, it would reach cms energies $\sim$ $3.4(2.2)$ TeV/nucleon, with similar luminosities. In this contribution we show the physics program that such high-energy DIS machines can provide standalone, comprising precision QCD in ep and eA, EW, top and Higgs physics, and BSM searches.

Authors: GWENLAN, Claire (University of Oxford (GB)); ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))

Presenter: GWENLAN, Claire (University of Oxford (GB))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **119** Type: **not specified**

The LHeC in the landscape of particle physics colliders

Tuesday 25 March 2025 11:00 (22 minutes)

The Large Hadron electron Collider is a proposed upgrade of the HL-LHC. It will add an energy recovery racetrack to the CERN accelerator complex. The ERL will provide 50 GeV electrons to collide with the LHC beams, resulting in ep (eA) collisions with cms energies $\sim 1.2(0.75)$ TeV/nucleon and instantaneous luminosities $\sim 10^{34}$ $(5 \cdot 10^{32})$ cm^{-2}s^{-1}. It could be built to start operation after the HL-LHC, and deliver integrated ep luminosities around 1 ab^{-1}, serving as a bridge between the LHC and the next flagship project at CERN. In this contribution, we show how the LHeC can act as an enabler for future particle physics colliders. First, the ERL technique and accelerator can be used for future e^+e^- colliders. Second, the detector may serve for technological developments for detectors in future colliders. Finally, we will show how measurements in ep are complementary and synergetic to those e^+e^- and hh, providing the ultimate experimental precision, e.g., for the extraction of Higgs couplings, thus completing the exploration of the TeV scale as HERA complemented LEP and Tevatron at the Fermi scale.

Author: ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))

Presenter: ARMESTO PEREZ, Nestor (Universidade de Santiago de Compostela (ES))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **120** Type: **not specified**

Structure of the Universe's Lightest Nuclei from the Light-Front Hamiltonian Approach

We study the internal structure of the deuteron at the level of its partons using the basis light-front quantization approach. The Hamiltonian is constructed by incorporating the fundamental QCD interactions arising from the six-quarks and six-quarks-gluon Fock components. We examine the deuteron's electromagnetic form factors, parton distribution functions, and tensor-polarized properties. Additionally, we explore the color structure, including the "hidden color"contribution within the deuteron.
Furthermore, we investigate the deuteron by treating it as a molecular-like system. We derive the light-front wave functions from two Schrödinger-like equations: the light-front holographic QCD equation and the 't Hooft equation, and study the properties of the deuteron.

Author: Dr KAUR, Satvir (Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou)

Presenter: Dr KAUR, Satvir (Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **121** Type: **not specified**

Dimuon production in DIS with charm-mass effects

Tuesday 25 March 2025 09:44 (22 minutes)

We present an update to our SIDIS-based approach for dimuon production in neutrino-nucleus collisions [1]. Dimuon production, an important constraint for the strange-quark distribution in global analyses of both proton and nuclear parton distributions, has traditionally been calculated by assuming factorization to the inclusive DIS charm production process. In our approach, we forego this assumption and instead compute dimuon production directly using semi-inclusive DIS and charged-hadron fragmentation functions. Our updated next-to-leading-order framework now includes full charm-quark mass corrections in a variable flavor number scheme. We assess the impact of these corrections and the effect they have on the agreement with NuTeV and CCFR dimuon data. We find that in the region of small momentum transfer, where the mass effects are the most impactful, the cross section values are reduced by up to 20%.

References:
[1] I. Helenius, H. Paukkunen and S. Yrjänheikki: Dimuons from neutrino-nucleus collisions in the semi-inclusive DIS approach, JHEP 09 (2024) 043 [arXiv:2405.12677]

Authors: PAUKKUNEN, Hannu; Dr HELENIUS, Ilkka (University of Jyväskylä); YRJÄNHEIKKI, Sami (University of Jyväskylä)

Presenter: YRJÄNHEIKKI, Sami (University of Jyväskylä)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **122** Type: **not specified**

South Africa's Contribution to the Upgrade of the ATLAS TileCal low voltage power supply for the HL-LHC

Wednesday 26 March 2025 09:22 (22 minutes)

The start of the operation of the High Luminosity LHC (HL-LHC) is planned for the year 2030. The associated increase in luminosity provides an opportunity for further scientific discoveries as while also introducing many technical challenges for the systems of the ATLAS experiment. The HL-LHC environment has necessitated the Phase-II upgrade of the ATLAS hadronic Tile-Calorimeter (TileCal) which will ensure its peak performance in the coming decades. The upgrade will take place during the third long shutdown of the LHC. It will encompass the replacement of both on- and off-detector electronics, the implementation of new on-detector mechanics as well as the replacement of Photo-multiplier tubes located in the most exposed regions of the detector. The on-detector electronics of the TileCal are powered by 256 adjacent Low-Voltage Power Supplies (LVPS) which themselves each contain eight transformer-coupled buck converters known as Bricks. These Bricks function to step-down power received from off-detector bulk power supplies to that required by the front-end electronics. The South African cluster, headed by the University of the Witwatersrand, is responsible for the research and development, production, quality assurance testing and integration of half of the required Bricks for the Phase-II Upgrade. This presentation will provide an overview of the South African cluster's contributions to the development and production of the LVPS Bricks for the ATLAS Tile-Calorimeter Phase-II Upgrade. It will highlight the current project milestones, including research, development, and quality assurance achievements, and conclude with a forward-looking perspective on the remaining activities critical for ensuring the success of the project.

Authors: GOLOLO, Mpho Gift Doctor (University of Johannesburg (ZA)); MCKENZIE, Ryan Peter (University of the Witwatersrand (ZA))

Co-authors: MELLADO GARCIA, Bruce (University of the Witwatersrand); PILUSA, Thabo (University of the Witwatersrand (ZA)); CHABALALA, Vongani Cyril (University of the Witwatersrand (ZA))

Presenter: GOLOLO, Mpho Gift Doctor (University of Johannesburg (ZA))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **123** Type: **not specified**

Precision simulations for ep colliders with SHERPA

Wednesday 26 March 2025 14:44 (20 minutes)

I report on recent progress in SHERPA's simulation of QCD processes in DIS and photo-production at current and future collider experiments.

Author: KRAUSS, Frank (IPPP Durham)

Presenter: KRAUSS, Frank (IPPP Durham)

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **124** Type: **not specified**

Diffraction in SHERPA

I report on recent process in the simulation of diffractive processes in SHERPA.

Author: KRAUSS, Frank Martin

Presenter: KRAUSS, Frank Martin

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **125** Type: **not specified**

Electroweak PDFs circa 2025: updates and prospects

Wednesday 26 March 2025 16:22 (22 minutes)

Due to the inclination for forward gauge radiation, lepton colliders beyond a few TeV are effectively electroweak boson colliders, suggesting the treatment of electroweak bosons as constituents of high-energy leptons. In this talk, we summarize the status of electroweak boson parton distribution functions, present new theoretical progress on their implementation, and give a brief outlook for their realistic implementation in TeV-scale hadron-hadron collisions.

Based on:
arXiv:2005.10289
arXiv:2111.02442
and work to appear

Author: RUIZ, Richard (Institute of Nuclear Physics (IFJ) PAN)

Presenter: RUIZ, Richard (Institute of Nuclear Physics (IFJ) PAN)

Session Classification: WG1/3: Joint session (WG1/3: Structure Functions and Parton Densities + Electroweak Physics and Beyond the Standard Model)

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **126** Type: **not specified**

Hard processes in multi-TeV ion collisions

Tuesday 25 March 2025 17:20 (20 minutes)

Motivated by the ion-collision program at the Large Hadron Collider, plans for its high-luminosity upgrade, and on-going discussions for multi-TeV future hadron colliders, we systematically investigate hard-scattering, Standard Model processes in many-TeV ion-ion collisions. We focus on the symmetric beam configurations for Pb-208, Xe-131, C-12, and the proton (for reference), catalog total and fiducial cross sections for dozens of processes, ranging from associated-Higgs and multi-boson production to associated-top pair production, at next-to-leading order in QCD for nucleon-nucleon collision energies from $\sqrt{s_{NN}} = 1$ to 100 TeV. We report on the emergence of trends and the reliability of extrapolating cross sections across different nuclei.

arXiv:2405.19399

Author: RUIZ, Richard (Institute of Nuclear Physics (IFJ) PAN)

Presenter: RUIZ, Richard (Institute of Nuclear Physics (IFJ) PAN)

Session Classification: WG1/6: Joint session (WG1/6: Structure Functions and Parton Densities + Future Experiment)

Track Classification: Structure Functions and Parton Densities

Contribution ID: **127** Type: **not specified**

Analytical study of target fluctuations in exclusive J/ψ production in γ-proton scattering.

We study the exclusive production of J/ψ in the photon-proton scattering using a hot spot model. The hot spot model is formulated in the framework of the MV model and in the dilute limit, which enable us to derive the analytical expressions for both coherent and incoherent cross sections. We determine analytically the contributions to the coherent and incoherent cross section from different sources of fluctuations, and compare the model calculation to the available HERA data. In particular, fluctuations in the saturation scale and in the number of hot spots which were neglected in the previous analytical works will be examined. In addition, the calculations are performed with the non-relativistic J/ψ wave function both with and without relativistic correction, which allow us to study analytically the effects of this correction on different observables.

Authors: LE, Anh-Dung (University of Jyväskylä); Dr MÄNTYSAARI, Heikki (University of Jyväskylä)

Presenter: LE, Anh-Dung (University of Jyväskylä)

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **128** Type: **not specified**

Towards a First-Principles Light-Front Hamiltonian Framework for the Nucleon

Basis light-front quantization (BLFQ) is a fully relativistic, nonperturbative approach that employs a light-front quantized Hamiltonian with Quantum Chromodynamics (QCD) inputs, aiming for first-principles calculations. For QCD applications in limited Fock space of the nucleon, we incorporate effective confinement into the Hamiltonian, achieving results consistent with global fits and experimental data on various nucleon properties. Recent advancements include extending Fock spaces to five- and six-particle sectors, such as five-quark, three-quark-two gluon, and three-quark-three-gluon configurations, as well as replacing the effective confining potential with relevant QCD interactions. BLFQ generated light-front wavefunctions enable the calculation of observables like quark and gluon parton distribution functions (PDFs) at low scales, with QCD evolution facilitating comparisons with experimental data. Additionally, we explore generalized parton distribution functions (GPDs), transverse momentum-dependent distributions (TMDs), and the spin decomposition of the nucleon. Prospects for further developments are also highlighted.

Author: MONDAL, Chandan

Presenter: MONDAL, Chandan

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **129** Type: **not specified**

Machine learning meets the high-x phase-space - improving gluon PDFs with machine learning

With the LHC transitioning to a precision measurement machine, the proton Parton Distribution Functions (PDFs) are becoming a leading source of uncertainty in analyses such as the measurements of top quark mass or the Higgs boson width. Furthermore, the high-momentum-fraction (high-x) regime is of particular interest when probing the most energetic collisions at the LHC. Thus, it is crucial to understand and potentially reduce the PDF uncertainties in this regime. Using machine learning techniques, we construct a discriminant sensitive to the gluon PDF in the high-x regime, to be used in future PDF fits.

Authors: DONG, BinBin (Michigan State University (US)); Mr FEIN, Jarrett (Michigan State University (US)); GOMBAS, Jason P. (Michigan State University (US)); SCHWIENHORST, Reinhard (Michigan State University (US)); Dr SINGH, Sahibjeet (Brookhaven National Laboratory (US))

Presenter: Dr SINGH, Sahibjeet (Brookhaven National Laboratory (US))

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **130** Type: **not specified**

Nucleon and Pion Parton Distributions from Lattice and Impacts on Global QCD Analysis

Wednesday 26 March 2025 09:00 (22 minutes)

There have been rapid developments in the direct calculation in lattice QCD (LQCD) of the Bjorken-x dependence of hadron structure through large-momentum effective theory (LaMET) and other similar effective approaches. These methods overcome the previous limitation of LQCD to moments (that is, integrals over Bjorken-x) of hadron structure, allowing LQCD to directly provide the kinematic Bjorken-x regions where the experimental values are least known. In this talk, I will show some selected recent progress for nucleon and pion PDFs and examples of how including lattice-QCD calculations in the global QCD analysis can play a significant role in improving our understanding of parton distributions in the future.

Author: LIN, Huey-Wen

Presenter: LIN, Huey-Wen

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **131** Type: **not specified**

k_T factorization approach and J/ψ production at Electron Ion collider

In this work we calculate the differential cross section for the J/ψ production in electron proton scattering. We use the k_T factorization approach with unintegrated gluon distribution function. We present distributions in transverse momentum and rapidity for COMPASS, JLab, HERMES and Electron Ion Collider centre of mass energies. Our results are compared with the experimental data for J/ψ production at electron-proton scattering experiments. We predict the total and differential cross section for the future Electron-Ion Collider (EIC) experiment. Our study is based on the off-shell photon-gluon fusion subprocess, where non-zero transverse momentum of the gluon is considered. We use parton level monte carlo event genrator KATIE for off-shell matrix element. We use different unintegrated parton distribution function (uPDFs) driven by the Ciafaloni–Catani–Fiorani–Marchesini (CCFM) evolution equation at low x. We study the production of J/ψ and its decay to μ^+ μ^- considering kinematical constraints. We use improved color evaporation model to consider the non-perturbative evolution of $c\bar{c}$ pair into J/ψ. This study will be important to understand the unintegrated gluon distribution function and role of transverse momentum of gluons. The k_T factorization approach together with offshell matrix element give a good description of experimental data.

Author: Dr RAWOOT, Vaibhav (Jaypee Institute of Information Technology Noida, India)

Co-author: KUMAR, Mukesh (University of the Witwatersrand (ZA))

Presenter: Dr RAWOOT, Vaibhav (Jaypee Institute of Information Technology Noida, India)

Track Classification: Small-x, Diffraction, and Vector Mesons

Contribution ID: **132** Type: **not specified**

Deep learning full phase-space measurement of high Q^2 ep collisions at HERA

Thursday 27 March 2025 09:00 (20 minutes)

Using modern machine learning, a measurement of all outgoing particles from high Q^2 electron-proton collisions is presented using data recorded with the H1 detector at HERA. The resulting differential cross section is unbinned and multi-dimensional, yet unfolded to the particle level. It thus allows for flexible reinterpretations.

Authors: BRITZGER, Daniel (Max-Planck-Institut für Physik München); COLLABORATION, H1 (DESY); ARRATIA, Miguel; SCHMITT, Stefan (Deutsches Elektronen-Synchrotron (DE)); ZHANG, Zhiqing Philippe (IJCLab, Orsay (FR))

Presenter: ARRATIA, Miguel

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **133** Type: **not specified**

Low Voltage Power Supply Quality Control with Machine Learning for ATLAS Tile-Calorimeter

Wednesday 26 March 2025 11:22 (22 minutes)

The Large Hadron Collider (LHC) will undergo its high-luminosity upgrade to increase its luminosity, affecting the ATLAS detector and, consequently, its hadronic Tile-Calorimeter (TileCal). As a part of the ATLAS Phase-II Upgrade project to adapt to the new high-luminosity environment, the TileCal is upgrading its low-voltage power supplies that power its on-detector front-end electronics. Over 1000 Bricks (transformer-coupled buck converters) housed within the Low Voltage Power Supplies (LVPS) are being manufactured in South Africa. Quality control is crucial due to the limited access to the Bricks once installed in the TileCal detector. A Brick failure would result in offline front-end electronics, degrading detector performance. This study proposes enhancing the current quality control procedures, test-bench station and burn-in station, by integrating machine learning techniques and anomaly detection models. Brick quality control data collected post-production ensures that they operate within design limits, increasing population reliability once on-detector. Subsequently, a fully connected neural network is trained using supervised learning on the test-bench station dataset to automate the detection of defective Bricks. This approach improves production checkout procedures with high accuracy, ensuring heightened efficiency and precision in identifying defective Bricks before installation within the TileCal at CERN.

Author: KUMAR, Mukesh (University of the Witwatersrand (ZA))

Presenter: MOSOMANE, Chuene Johannes (University of the Witwatersrand (ZA))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **135** Type: **not specified**

A Burn-in Test Station for the Transformer-Coupled Buck Converter Boards within the Low Voltage Power Supplies of the ATLAS Tile Calorimeter

Wednesday 26 March 2025 10:06 (22 minutes)

A comprehensive quality assurance testing procedure is developed to ensure the reliability of transformer-coupled buck converter boards (Bricks) within the ATLAS hadronic Tile Calorimeter (TileCal). With the impending Phase-II upgrades of the TileCal, which will contribute to the success of the forthcoming High-Luminosity Large Hadron Collider, ensuring the reliability of the Bricks in the TileCal's Low Voltage Power Supply (LVPS) system is essential. There are 256 LVPS Boxes within the TileCal, each equipped with eight Bricks that step down 200 V direct current power received from the off-detector electronics to the voltage required by the on-detector front-end electronics. The South African cluster as a part of the Phase-II upgrades, is taking a significant role in production by manufacturing half of all the Bricks required. Access to the Bricks is limited to once per year during the Year-End Technical Stops due to their location within the inner barrel of the ATLAS detector. As a result, if a Brick failure occurs it may be offline for up to one year with the front-end electronics to which it supplies power being offline for a commensurate period. Establishing a Burn-in test station is essential, aimed at subjecting LVPS Bricks to accelerated ageing to stimulate failure mechanisms and screening out defective Bricks that would compromise the detector's performance. By ensuring the reliability of the final population of Bricks installed, we minimize instances of the front-end electronics being offline, thus improving detector performance and data integrity.

Authors: KUMAR, Mukesh (University of the Witwatersrand (ZA)); PILUSA, Thabo (University of the Witwatersrand (ZA))

Presenter: PILUSA, Thabo (University of the Witwatersrand (ZA))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **136** Type: **not specified**

An overview of the test station involved in the production of the LVPS Bricks for the Phase II upgrade of the ATLAS Tile Calorimeter

Wednesday 26 March 2025 11:00 (22 minutes)

The Phase II upgrade of the ATLAS experiment at CERN represents a significant advancement in preparing for the High Luminosity Large Hadron Collider (HL-LHC) era. This upgrade includes substantial enhancements to the detector, particularly the integration of radiation-resistant transformer-coupled buck converters, referred to as Low Voltage Power Supply (LVPS) bricks. A thorough quality assurance process is being implemented to improve the reliability of LVPS bricks within the ATLAS Hadronic Tile-Calorimeter (TileCal). In partnership with the University of the Witwatersrand and iThemba LABS, more than a thousand LVPS bricks will be developed. These bricks are essential for converting 200 V direct current (DC) power into the 10 V DC power needed for detector operation. Extensive initial testing of these bricks is critical to ensure their reliability and performance under the challenging conditions anticipated in the HL-LHC era, including high radiation levels, increased trigger rates, and substantial pile-up. The next phase will involve gathering and analysing test data using advanced machine learning techniques. This data-driven approach will offer deeper insights into the bricks' behaviour under extreme conditions, enabling the optimization of their design and performance to meet the demanding requirements of the HL-LHC.

Authors: KUMAR, Mukesh (University of the Witwatersrand (ZA)); CHABALALA, Vongani Cyril (University of the Witwatersrand (ZA)); CHABALALA, Vongani Cyril (University of the Witwatersrand (ZA))

Presenters: KUMAR, Mukesh (University of the Witwatersrand (ZA)); CHABALALA, Vongani Cyril (University of the Witwatersrand (ZA))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **137** Type: **not specified**

Hadronization Dynamics in the Nuclear Medium: Preliminary Insights from the CLAS12 RGE Experiment at Jefferson Lab

The study of hadronization—the process by which quarks and gluons transition into hadrons—is fundamental to understanding the strong interaction dynamics within quantum chromodynamics (QCD). Using the CLAS12 detector at Jefferson Lab, the Run Group E (RGE) experiment offers unprecedented insights into hadronization in the nuclear medium. This talk will present preliminary results from the experiment, focusing on the behavior of hadrons produced in 12 GeV electron-nucleus scattering.The experiment employs various nuclear targets, enabling a comparative study of medium effects on hadron formation and propagation. By analyzing observables such as hadron multiplicity ratios, transverse momentum broadening, and energy loss, we explore the interaction of quarks and hadrons with the nuclear environment. These measurements provide critical data for understanding color confinement and hadronization timescales, shedding light on QCD processes in dense media. The talk will also highlight the innovative Double-Target system developed for RGE, which facilitates rapid target switching to enhance data collection efficiency.

Author: Prof. HAKOBYAN, Hayk (Universidad Tecnica Federico Santa Maria)

Presenter: Prof. HAKOBYAN, Hayk (Universidad Tecnica Federico Santa Maria)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **138** Type: **not specified**

First Physics Results from milliQan

We will report the status of the milliQan experiment at CERN. The milliQan "bar" detector was completed in June 2023 and has been taking physics data since then. The milliQan "slab" detector was completed in Fall of 2024 and is being commissioned. We will give an update on the readiness of the slab detectorfor physics data taking. Finally, we will present first physics results on the search for millicharged particles in 127 fb^{-1} pp collision data recorded by the bar detector during Run 3 of the LHC.

Author: HILL, Chris (Ohio State University (US))

Co-author: HAAS, Andy (New York University)

Presenter: HILL, Chris (Ohio State University (US))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **139** Type: **not specified**

Updates of MSHT PDFs

Tuesday 25 March 2025 11:00 (32 minutes)

I present updates related to the parton distribution functions (PDFs) obtained using the MSHT approach. I address inclusion of new data types, e.g. LHC dijet data, studies of strong coupling dependence and determinations, and closure tests and comparison to the neural network approach and implications for best fits and uncertainties.

Author: THORNE, Robert Samuel (University College London (UK))

Co-authors: Dr HARLAND-LANG, Lucian Alexander (University College London); CRIDGE, Thomas

Presenter: THORNE, Robert Samuel (University College London (UK))

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **140** Type: **not specified**

Inclusive single hadron and jet production in lepton-hadron scattering

With a large momentum transfer, high energy lepton-hadron deep inelastic scattering induces both QCD and QED radiations. In this talk, we present the first NLO calculation of inclusive single hadron/jet production at large transverse momentum in lepton-hadron scattering in a joint QCD and QED factorization approach [1]. Both QCD and QED collision-induced radiation are treated equally and their collinear sensitivities are systematically factorized into corresponding universal lepton and parton distribution functions. As a result, the scattering cross section is factorized into a convolution of infrared-safe hard coefficient functions with universal lepton distribution functions (LDFs) and parton distribution functions (PDFs) of the colliding lepton and hadron, respectively, together with fragmentation functions (FFs) of the observed hadron (or jet). With the joint QCD and QED factorization, the DGLAP-type evolution equations for LDFs, PDFs, and FFs are necessary to have evolution kernels calculated in both QCD and QED [2]. We discuss the strategy for extracting the universal and non-perturbative LDFs and derive a set of LDFs for our calculations. We present our predictions for inclusive single hadron (and jet) production at the energies of Jefferson Lab and the future Electron-Ion Collider. We also discuss the unique role of this process in comparing and complementing the better-studied inclusive deep inelastic scattering [3] and semi-inclusive deep inelastic scattering.

[1] "A new approach to semi-inclusive deep-inelastic scattering with QED and QCD factorization," T. Liu, et al. JHEP11 (2021) 157.
[2] "Physics case for quarkonium studies at the Electron Ion Collider,"D. Boer, et al. arXiv:2409.03691
[3] "Factorized QED Contribution to Lepton-Hadron DIS,"J. Cammarota, et al. arXiv:2408.08377

Authors: Dr QIU, Jianwei (Jefferson Lab); WATANABE, Kazuhiro (Tohoku University)

Presenters: Dr QIU, Jianwei (Jefferson Lab); WATANABE, Kazuhiro (Tohoku University)

Session Classification: WG4: QCD with Heavy Flavors and Hadronic Final States

Track Classification: QCD with Heavy Flavors and Hadronic Final States

Contribution ID: **141** Type: **not specified**

The ePIC Silicon Vertex Tracker Barrel: design and first thermal-mechanical tests.

Wednesday 26 March 2025 16:44 (22 minutes)

The future Electron Ion Collider (EIC) will offer a unique opportunity to explore the parton distributions inside nucleons and nuclei thanks to an unprecedented luminosity, a wide range of energies, a large choice of nuclei and polarization of both beams.
The electron Proton-Ion Collider (ePIC) detector will be capable of precise determination of the position of primary and secondary vertexes, essential e.g. for the identification of charm hadrons, which have typical decay lengths of the order of 100 microns, via topological cuts, giving access to the gluon distribution inside hadrons.
This measurement capability is achieved with a Silicon Vertex Tracker (SVT) placed as the innermost device in the ePIC experiment.
The SVT Inner and Outer Barrel (IB,OB), developed by a collaboration of Italy-UK-USA institutes, provide five detecting layers
made of silicon detectors, using the 65 nm MAPS technology with stitching, pioneered by the ALICE collaboration for the ITS3 upgrade.
The IB main focus is on vertexing performance. It is made of three layers of wafer-scale sensors bent to a cylindrical shape. The OB, composed of two layers, mainly contributes to the particle momentum
measurement and it is equipped with a smaller version of the IB sensor mounted in a typical stave configuration. The status of the design and first results of tests performed on thermal-mechanical mock-ups of the detector will be presented.

Note this talk will be on zoom at the following link:
https://cern.zoom.us/j/5044889950?pwd=ODlELzNyZDU0NWNENjVYbXZDZVpYdz09

Authors: ELIA, Domenico (INFN Bari); TURRISI, Rosario (Universita e INFN, Padova (IT))

Presenter: ELIA, Domenico (INFN Bari)

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **142** Type: **not specified**

Gravitational Form Factors Through the Application of Novel Computational Techniques

Wednesday 26 March 2025 09:00 (25 minutes)

Direct measurements of gravitational form factors (GFFs) are extremely challenging and nearly impossible due to the weakness of gravitational interactions. However, processes such as deeply virtual Compton scattering (DVCS) offer an effective way to study GFFs indirectly by mimicking graviton tensor interactions. Our work integrates insights from experimental physics, lattice QCD, and computational science to enhance data analysis using theoretical constraints and neural network-based fitting methods. These advancements aim to reduce model dependence and improve the precision of GFF extraction, thereby shedding light on the proton's mechanical properties.

Author: ANGULO, Isela Melany (Jefferson Lab)

Presenter: ANGULO, Isela Melany (Jefferson Lab)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **143** Type: **not specified**

Searches for lepton-flavour-violating processes at CMS

Wednesday 26 March 2025 11:20 (20 minutes)

New physics can manifest itself via lepton-flavour-violating processes in LHC proton-proton collisions. In the past years, different experiments have reported possible indications of new physics violating the lepton-flavour-universality symmetry of the Standard Model. This talk summarizes the most recent searches and precision measurements for lepton-flavour-violating processes with the CMS detector, using proton-proton collisions at a centre-of-mass energy of 13 TeV.

Author: MARCHESE, Luigi (ETH Zurich (CH))

Presenter: MARCHESE, Luigi (ETH Zurich (CH))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **146** Type: **not specified**

Highlights on searches for long live particles at CMS

Wednesday 26 March 2025 11:40 (20 minutes)

Long-lived particles (LLPs) produced at the LHC travel a macroscopic distance before decaying, producing a unique experimental signature. This is an ideal probe for searching beyond standard model physics and the CMS collaboration has a wide program covering different final states. Recent results on CMS searches for LLP decaying to leptons and hadrons is presented focusing both on inclusive and exclusive searches.

Authors: SANTOCCHIA, Attilio (Universita e INFN, Perugia (IT)); YUAN, Li (Beihang University (CN))

Presenter: SANTOCCHIA, Attilio (Universita e INFN, Perugia (IT))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **152** Type: **not specified**

Studies of anomalous couplings of the Higgs boson and its CP structure at CMS

Tuesday 25 March 2025 15:00 (20 minutes)

We present the most recent studies of anomalous couplings of the Higgs boson and its CP structure at the CMS experiment. These studies probe BSM effects, such as CP conserving or CP violating couplings to particles with masses not directly accessible at the LHC through virtual quantum loops. Results in the context of effective field theories (EFT) will also be presented.

Author: PONCET, Oceane (Centre National de la Recherche Scientifique (FR))

Presenter: PONCET, Oceane (Centre National de la Recherche Scientifique (FR))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **153** Type: **not specified**

Highlights from searches with heavy bosons and tops

Tuesday 25 March 2025 09:40 (20 minutes)

Many models of physics beyond the Standard Model (SM) contain enhanced couplings to massive standard model particles like the W,Z,Higgs, and top. We present highlights of searches for new physics beyond the SM in final states containing these heavy particles, using proton-proton collision data collected with the CMS detector at the CERN LHC. The models probed can contain heavy gauge or higgs bosons, excited quarks, gravitons, and both chiral and vector-like top and bottom quark partners. Many results use novel analysis techniques to identify and reconstruct highly boosted final states that are created in these topologies.

Author: LEONIDOU, Christos (University of Cyprus (CY))

Presenter: LEONIDOU, Christos (University of Cyprus (CY))

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **154** Type: **not specified**

Searches for additional Higgs bosons (high & low mass) at CMS (Online talk)

Wednesday 26 March 2025 12:00 (20 minutes)

Recent highlights of searches for additional non-standard-model Higgs bisons from the CMS experiment are presented.

Author: CHEN, Ye

Presenter: CHEN, Ye

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **158** Type: **not specified**

Physics results with the CMS Precision Proton Spectrometer and projections for the HL-LHC with PPS2

Tuesday 25 March 2025 14:44 (22 minutes)

In this talk, we present the recent searches for new physics in the electroweak sector of the Standard model containing intact protons measured by the CMS Precision Proton Spectrometer (PPS). With the higher event pileup expected in the high-luminosity upgrade of the LHC, a tighter selection of intact protons under increasingly challenging conditions is required. In this view, the PPS2 project will be presented and projections for future searches at the HL-LHC with intact protons will be discussed."

Authors: FORTHOMME, Laurent (AGH University of Krakow (PL)); YUAN, Li (Beihang University (CN))

Presenter: FORTHOMME, Laurent (AGH University of Krakow (PL))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **159** Type: **not specified**

Bridging the Gap: Connecting Atomic Nuclei to Their Quantum Foundations

Wednesday 26 March 2025 14:22 (22 minutes)

Within the nCTEQ collaboration, we have developed a novel nuclear parton distribution function (nPDF) framework inspired by Short-Range Correlations (SRCs) to bridge the nuclear and particle physics descriptions of nuclei. Initial investigations show that this SRC-based approach yields improved fits as compared to traditional methods, suggesting it may better capture nuclear properties. Additionally, this framework provides a new way to link general nuclear properties, such as "magic number" and "mirror" nuclei, to the internal behavior of quarks and gluons within the nucleus. We review the outcomes of this study and discuss future directions, along with potential implications for the upcoming Electron-Ion Collider (EIC) program.

Authors: DENNISTON, Andrew (MIT); JEZO, Tomas (WWU ITP); HEN, Or; KEPPEL, Cynthia (Thia); KLASEN, Michael; KUSINA, Aleksander; Prof. OLNESS, Fred (Southern Methodist University (US))

Presenter: Prof. OLNESS, Fred (Southern Methodist University (US))

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **160** Type: **not specified**

Status of ABMP16/ABMPtt/ABMPgam PDF fits

Tuesday 25 March 2025 11:32 (22 minutes)

We study the impact of state-of-the-art top-quark data collected at the Large Hadron Collider (LHC) on proton parton distribution functions (PDFs) using the ABMP16 methodology. The gluon PDF at large x and the top-quark mass value derived from these data are well compatible with the previous ABMP16 results, but with significantly reduced uncertainties by up to a factor of two. We discuss the compatibility of different datasets and the compatibility of the fitted PDFs with other modern global PDF sets. Th new PDF set is used to compute cross sections for benchmark processes at the LHC, such as Higgs production. Also we discuss the availability of the tools used in our work within the open-source xFitter project. In addition, we present preliminary results considering the QCD+QED evolution.

Authors: GARZELLI, Maria Vittoria (Hamburg University (DE)); ZENAIEV, Oleksandr (Hamburg University); Dr ALEKHIN, Sergey (Hamburg University); MOCH, Sven-Olaf (Hamburg University (DE))

Presenter: ZENAIEV, Oleksandr (Hamburg University)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **161** Type: **not specified**

Updated predictions for toponium production at the LHC

Tuesday 25 March 2025 10:00 (20 minutes)

We provide an update on QCD predictions for top-quark pair production close to threshold including bound state effects at the Large Hadron Collider (LHC) [arXiv:2412.16685]. We compute the top-quark pair invariant mass distribution, including Coulomb resummation for bound-state effects, as well as threshold resummation for emissions of soft and collinear gluons. We discuss uncertainty estimates and present a proposal for the use of these predictions in experimental analyses. We comment on the impact of these effects in top-quark mass extraction using state-of-the-art top-quark data at the LHC.

Authors: LIMATOLA, Giovanni; GARZELLI, Maria Vittoria (Hamburg University (DE)); ZENAIEV, Oleksandr (Hamburg University); MOCH, Sven-Olaf (Hamburg University (DE)); STEINHAUSER, Matthias (KIT)

Presenter: ZENAIEV, Oleksandr (Hamburg University)

Session Classification: WG3: Electroweak Physics and Beyond the Standard Model

Track Classification: Electroweak Physics and Beyond the Standard Model

Contribution ID: **163** Type: **not specified**

The q_T spectrum of J/ψ production at the EIC

Wednesday 26 March 2025 09:25 (25 minutes)

The production of quarkonia, and in particular J/ψ, at the EIC is a valuable tool to probe the gluon transverse momentum dependent (TMD) distributions at lower energies as compared, for instance, to Higgs production. However, the proper factorization must be adopted to describe J/ψ production at small transverse momentum accurately. This requires the introduction of a new TMD object, the so-called TMD shape function (TMD-ShF), which encodes smearing effects associated with the quarkonium production mechanism. The J/ψ production is thus expressed in terms of the gluon TMD-PDF and the aforementioned TMD-ShF, identifying the W term, which can then be combined with the collinear fixed-order calculation to obtain a unified description valid across all transverse momenta.
In this talk I will present a phenomenological derivation of the TMD-ShF from the asymptotic behavior of the fixed-order cross section. I will then explore the combination of the W and fixed-order terms to investigate properties of the overall distribution, emphasizing the role of the TMD-ShF in shaping them.

Author: MAXIA, Luca (LPTHE - CNRS)

Presenter: MAXIA, Luca (LPTHE - CNRS)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **164** Type: **not specified**

Studying Nucleon Spin Structure at the Spin Physics Detector (SPD)

Wednesday 26 March 2025 09:50 (25 minutes)

Primary focus of the Spin Physics Detector (SPD) at the Nuclotron based Ion Collider fAcility (NICA) is to study nucleon spin structure in the three dimensions. At the SPD, measurements of cross-sections and spin asymmetries sensitive to the unpolarized and various polarized (helicity, Sivers, Boer-Mulders) gluon distributions will be performed. Measurements from collisions of polarized protons (deuterons) of energies up to 27 (13.5) GeV with luminosity up to 10ˆ32 cmˆ{−2} sˆ{−1} (10ˆ31 cmˆ{−2} sˆ{−1}) will provide data in the moderate and large Bjorken-x, making them complementary to the present (i.e. STAR, PHENIX) and future (i.e. EIC, AFTER) high energy spin experiments. This will allow for a much improved global analyses and understanding of spin structures of a basic building block of Nature. With polarized deuteron collisions, SPD will be a unique laboratory for probing tensor polarized gluon distr

Author: DATTA, Amaresh (Joint Institute for Nuclear Research)

Presenter: DATTA, Amaresh (Joint Institute for Nuclear Research)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **166** Type: **not specified**

Experiment Errors in PDF determination

As experimental data is becoming more precise, understanding the impact of the uncertainties in the errors,

especially the systematic errors, is increasingly becoming a significant focus of PDF groups. In this talk I will

explain how the error on errors can be modelled and how this framework can be applied to both uncorrelated

and correlated systematic errors. We will then investigate what this can tells us about the ATLAS W,Z dataset.

We will then discuss the process of decorrelation, and examine the impact on the χ^2 using different

procedures We will then introduce a different way to consider decorrelation. Lastly we will investigate

asymmetric systematic errors and examine the impact on the χ^2 using different approaches.

Author: READER, Matthew

Co-author: THORNE, Robert Samuel (University College London (UK))

Presenter: READER, Matthew

Track Classification: Structure Functions and Parton Densities

Contribution ID: **167** Type: **not specified**

Fast NNLO Implementation of the aSACOT scheme for DIS

Tuesday 25 March 2025 10:06 (22 minutes)

Mass-dependent quark contributions are of great importance to DIS processes. The simplified-ACOT-χ scheme includes these effects over a wide range of momentum transfers up to next-to-leading order in QCD. In recent years an improvement in the case of neutral current DIS has been achieved by using zero-mass contributions up to next-to-next-to-leading order (NNLO) with massive phase-space constraints. In this talk, we extend this approach to the case of charged current DIS and provide an implementation in the open-source code APFEL++. The increased precision will be valuable for understanding current and future neutrino experiments, the Electron-Ion-Collider and the studies of partonic substructure of hadrons and nuclei. A highly efficient implementation using gridding techniques extends the applicability of the code to the determination of parton distribution functions (PDFs).

Authors: Prof. OLNESS, Fred (Southern Methodist University (US)); RISSE, Peter (Southern Methodist University); JEZO, Tomas (WWU ITP); Dr BERTONE, Valerio (C.E.A. Paris-Saclay)

Presenter: Dr BERTONE, Valerio (C.E.A. Paris-Saclay)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **168** Type: **not specified**

The CMS Muon System Upgrades for the HL-LHC

Tuesday 25 March 2025 09:22 (22 minutes)

Physicists anticipate that new physics phenomena will be discovered and/or confirmed during the High Luminosity Large Hadron Collider (HL-LHC) program. The primary argument is that the instantaneous luminosity will increase to 5-7.5 x 10ˆ34 cm-2 s-1, approximately ten times the expected integrated luminosity of the LHC. This high-rate environment presents new challenges for the muon system of the Compact Muon Solenoid (CMS) experiment. To maintain high performance under these new data-taking conditions and to enhance the current tracking and triggering capabilities, the muon system will undergo targeted upgrades. These upgrades will affect all legacy muon sub-systems: Drift Tubes (DT) and Resistive Plate Chambers (RPC) in the barrel region, as well as Cathode Strip Chambers (CSC) and RPCs in the endcap region. The upgrades include replacing the on-detector and backend electronics of the existing detectors. Additionally, to ensure redundancy in the high-eta region and extend coverage up to |η| ˜2.8 , new stations utilizing triple Gas Electron Multipliers (GEM) and Improved RPCs (iRPC) will be installed. This report presents performance results of the installed muon sub-systems using Run-3 data. It also provides an update on the production and validation tests of the new detectors scheduled for installation before and during LS3.

Co-author: MEOLA, Sabino (INFN e Laboratori Nazionali di Frascati (IT))

Presenter: MEOLA, Sabino (INFN e Laboratori Nazionali di Frascati (IT))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **169** Type: **not specified**

Detector concepts for a 10 TeV Muon Collider

Tuesday 25 March 2025 11:22 (32 minutes)

A 10 TeV Muon Collider has been proposed as the next energy frontier machine, with expected physics prospects that far surpasses the current knowledge in a large variety of Standard Model measurements and Beyond Standard Model searches. Due to the short lifetime of muons, however, high-energy electrons that interact with shielding elements produce a large amount of beam-induced background (BIB). The detector design for such a collider has to be able to handle such a background preserving excellent performance for detecting the decay products of the muon-muon collisions.
In this contribution I will give a short overview of the main detector concepts considered so far and how they relate to key physics measurements that are part of the core physics program for such a collider.

Author: PAGAN GRISO, Simone (Lawrence Berkeley National Lab. (US))

Presenter: PAGAN GRISO, Simone (Lawrence Berkeley National Lab. (US))

Session Classification: WG6: Future Experiments

Track Classification: Future Experiments

Contribution ID: **170** Type: **not specified**

The Neutral Particle Spectrometer (NPS) in Hall C of Jefferson Lab.

Wednesday 26 March 2025 11:00 (25 minutes)

The Neutral Particle Spectrometer (NPS) in Hall C of the Thomas Jefferson National Accelerator Facility (aka Jefferson Lab) is a standalone electromagnetic calorimeter for detecting high energy photons. The NPS science program is a suite of ten approved precision experiments of small cross sections divided into two run groups. The first run group, RG1A, consists of the measurement of exclusive Deeply Virtual Compton Scattering (DVCS) off both a proton (LH2) and a neutron (LD2) target, Deeply Virtual Meson Production (DVMP) with neutral pions, and semi-inclusive deep-inelastic (SIDIS) with neutral pions, cross sections to the highest Q2 and a wide range in x-Bjorken accessible at Jefferson Lab. DVCS and DVMP channels are necessary to map out the 3D structure of the nucleons in the Generalized Parton Distribution (GPD) framework. The SIDIS off the proton (with the neutral pion) channel cross sections aim to access Transverse Momentum Distributions (TMDs) and also seeks to validate the factorization framework that is needed by the entire 12 GeV semi-inclusive deep-inelastic scattering program and beyond 12 GeV. The RG1A experiments ran from September 2023 to May 2024 on both proton (hydrogen) and neutron (deuterium) targets. In this talk, an overview, status, and a brief analysis update of the R1GA experiments will be discussed.

Author: DLAMINI, Mongi (University of eSwatini)

Presenter: DLAMINI, Mongi (University of eSwatini)

Session Classification: WG5: Spin and 3D Structure

Track Classification: Spin and 3D Structure

Contribution ID: **172** Type: **not specified**

Systematic uncertainties from higher-twist corrections in DIS at large x

Wednesday 26 March 2025 09:22 (22 minutes)

We investigate the systematic uncertainties and potential biases arising from the inclusion of large-x corrections to proton and deuteron DIS data in global QCD analyses. Using the CTEQ-JLab framework, we examine various approaches to implementing higher-twist corrections in nucleon structure functions and off-shell PDF modifications in deuteron targets. We analyze how these components interact and influence the determination of the d-quark PDF and the neutron structure function at large x. We find that it is very important to consider isospin-dependent higher-twist corrections in order to minimize implementation biases in the extracted quantities.

Authors: CERUTTI, Matteo (Christopher Newport University and Jefferson Lab); ACCARDI, Alberto (Christopher Newport U. and Jefferson Lab); FERNANDO, Ishara (University of Virginia); LI, Shujie (Berkeley Lab); OWENS, Jeff (Florida State University); PARK, Sanghwa (Jefferson Lab)

Presenter: ACCARDI, Alberto (Christopher Newport U. and Jefferson Lab)

Session Classification: WG1: Structure Functions and Parton Densities

Track Classification: Structure Functions and Parton Densities

Contribution ID: **173** Type: **not specified**

High-energy two-photon interactions at future ep colliders

Thursday 27 March 2025 08:50 (20 minutes)

High energy two-photon processes provide unique opportunity for studying with high precision the electroweak sector of particle interactions at future colliders. In particular, future facilities such as the LHeC, FCC-eh, or the eh-CEPC, will ensure very advantageous experimental conditions and at the same time provide high two-photon luminosities, reaching the TeV scale. In this talk we will give an overview of expected performance of these colliders in that context. In addition, the impact of tagging two-photon processes using very forward detectors will also be presented.

Author: FORTHOMME, Laurent (AGH University of Krakow (PL))

Presenter: FORTHOMME, Laurent (AGH University of Krakow (PL))

Session Classification: WG3/6: Joint session

Track Classification: Future Experiments

Contribution ID: **174** Type: **not specified**

WELCOME

Session Classification: PLENARY

Contribution ID: **175** Type: **not specified**

Hybrid high-energy factorization and evolution at NLO

Tuesday 25 March 2025 09:00 (20 minutes)

Presenter: VAN HAMEREN, Andreas

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **176** Type: **not specified**

A new TMD factorization for large and small x

Presenter: TIWARI, Shaswat

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **177** Type: **not specified**

Measurement of the sensitivity of two-particle correlations in pp collisions to the presence of hard scatterings

Tuesday 25 March 2025 09:20 (20 minutes)

A key open question in the study of multi-particle production in high-energy collisions is the relationship between the "ridge" - observed azimuthal correlations between particles in the underlying event that extend over all rapidities and hard or semi-hard scattering processes. In particular, it is not known whether jets or their soft fragments are correlated with particles in the underlying event. This talk presents measurements of two-particle correlations in collisions at TeV with two different particle-pair selections. In the first case, charged particles associated with jets are excluded from the correlation analysis. This shows that excluding charged particles associated with jets does not affect the measured correlations. In the second case, correlations are measured between particles within jets and charged particles from the underlying event. Particles associated with jets do not exhibit any significant azimuthal correlations with the underlying event, ruling out hard processes contributing to the ridge.

Presenter: BALEK, Petr (AGH University of Krakow (PL))

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **178** Type: **not specified**

Diffraction in SHERPA

Presenter: KRAUSS, Frank

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **179** Type: **not specified**

Automatic differentiation for Balitsky-Kovchegov equation

Tuesday 25 March 2025 11:00 (20 minutes)

Presenter: STEBEL, Tomasz

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **180** Type: **not specified**

Inferring the initial condition for the BK evolution at next-to-leading order accuracy

Tuesday 25 March 2025 11:20 (20 minutes)

Presenter: CASUGA, Carlisle

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **181** Type: **not specified**

Measurement of dijet photoproduction in ultraperipheral Pb+Pb collisions with ATLAS

Wednesday 26 March 2025 09:00 (20 minutes)

In ultra-relativistic heavy ion collisions, the charged ions produce an intense flux of equivalent photons. Photon-induced processes are the dominant interaction mechanism when the colliding nuclei have an impact parameter larger than the nuclear diameter. In these ultra-peripheral collisions (UPCs), the photon provides a clean, energetic probe of the partonic structure of the nucleus, analogous to deep inelastic scattering. This talk presents a measurement of jet production in UPCs performed with the ATLAS detector using high-statistics 2018 Pb+Pb data. Events are selected using requirements on jet production, rapidity gaps, and forward neutron emission to identify inclusive photo-nuclear hard-scattering processes. These measurements also include detailed studies of rapidity gap distributions and nuclear break-up effects, allowing for precise comparisons between data and theory for inclusive photo-nuclear processes. The measured cross-sections are compared to theoretical models in phase-space regions where significant nuclear PDF modifications are expected but not well constrained by world data, demonstrating the potential of these data to provide a strong new constraint on nPDF effects.

Author: GILBERT, Benjamin Jacob (Lawrence Livermore Nat. Laboratory (US))

Presenter: GILBERT, Benjamin Jacob (Lawrence Livermore Nat. Laboratory (US))

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **182** Type: **not specified**

Results on photon-photon scattering processes in ultra-peripheral Pb+Pb collisions with ATLAS

Wednesday 26 March 2025 09:40 (20 minutes)

In ultra-relativistic heavy-ion collisions, large rates of $\gamma\gamma$ processes occur through the interaction of the large electromagnetic fields of the nuclei. These $\gamma\gamma$ interactions enable the study of processes potentially sensitive to physics beyond the Standard Model. In ultra-peripheral collisions (UPCs), characterized by large impact parameter between the nuclei, the outgoing particles exhibit back-to-back production in the transverse plane, which provides precise and efficient identification. This talk presents an overview of recent ATLAS measurements potentially senstive to physics beyond the Standard Model, including the production of tau leptons, light-by-light scattering, or the production of magnetic monopoles. Measurements of tau lepton production help to constrain its anomalous magnetic moment, a quantity potentially sensitive to physics beyond the Standard Model. Results will be presented on measurements of light-by-light scattering which may be used to set limits on the existence of axion-like-particles (ALPs). Also presented is a more recent search for monopole-pair production in UPCs with monopole masses ranging from 20–150 GeV. The results are compared with a leading-order model of spin-1/2 particle production from photon–photon fusion and a recently developed semi-classical model that includes non-perturbative cross section calculations.

Presenter: DYNDAL, Mateusz (AGH University of Krakow)

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **183** Type: **not specified**

3 Inclusive and Exclusive Photonuclear Interactions in Ultra-Peripheral Collisions with ALICE

Wednesday 26 March 2025 09:20 (20 minutes)

Presenter: BYLINKIN, Sasha

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **184** Type: **not specified**

Probing Weizsacker-Williams Gluon Helicity Distribution in Longitudinally Polarized Electron-Proton Collisions

Wednesday 26 March 2025 11:00 (20 minutes)

Presenter: LI, Ming

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **185** Type: **not specified**

DIS dijet production at next-to-eikonal order

Wednesday 26 March 2025 11:20 (20 minutes)

Co-author: MULANI, Swaleha

Presenters: ARMESTO, Nestor; MULANI, Swaleha

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **186** Type: **not specified**

Probing initial state effects in nuclear collisions via dijet and spectator neutron measurements with the ATLAS detector

Wednesday 26 March 2025 12:00 (20 minutes)

The measurement of dijets in proton-lead collisions at the LHC offers unique possibilities for investigating both nuclear and nucleon initial state effects as a function of parton scattering kinematics. In particular, color fluctuation effects can significantly alter the average interaction strength of the proton, affecting the number of nucleon-nucleon interactions with the Pb nucleus and, therefore, the event activity. Both event activity and break-up neutrons, detected by Zero Degree Calorimeters, are common estimators used to assess the geometry of the p+Pb collision. This talk presents recent results obtained through the analysis of dijet events in $\sqrt{s_{\mathrm{NN}}} = 8.16$ TeV \textit{p}+Pb data collected by ATLAS in 2016. ATLAS has measured the sensitivity of both forward transverse energy and zero-degree spectator neutron energy to changes in the Bjorken-x of the parton originating from the proton (x_p) in the hard-scattering. Both of these estimators exhibit a systematic negative bias in events characterized by a high x_p, although the spectator neutron energy is found to be much less sensitive to these selections than the forward transverse energy. By measuring geometry estimators in well-separated regions of rapidity, this result can provide complementary constraints for color fluctuation modeling. Furthermore, the spectator neutron energy is a novel observable that reflects the number of wounded nucleons and the dynamics of nuclear evaporation.

Presenter: STEINBERG, Peter Alan (Brookhaven National Laboratory (US))

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **187** Type: **not specified**

Analytical study of target fluctuations in exclusive j/psi production in-proton scattering

Presenter: LE, Anh-Dung

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **188** Type: **not specified**

kTfactorization approach and j/psi production at Electron Ion collider

Presenter: RAWOOT, Vaibhav

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **189** Type: **not specified**

One-loop corrections to single and double inclusive hadron production in DIS at small x: signatures of gluon saturation at the Electron-Ion Collider

Presenter: JALILIAN-MARIAN, Jamal J

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **190** Type: **not specified**

Guido Altarelli Award

Monday 24 March 2025 09:45 (45 minutes)

The Guido Altarelli Award honors the memory of the late Guido Altarelli, one of the founding fathers of QCD, an outstanding communicator of particle physics, and a mentor and strong supporter of Junior Scientists.

Presenter: Prof. OLNESS, Fred (Southern Methodist University (US))

Session Classification: PLENARY

Contribution ID: **191** Type: **not specified**

An Homage to James Bjorken

Monday 24 March 2025 09:00 (45 minutes)

Presenter: MANGANO, Michelangelo (CERN)

Session Classification: PLENARY

Contribution ID: **192** Type: **not specified**

Report from the European Strategy

Friday 28 March 2025 10:00 (30 minutes)

Presenter: JAKOBS, Karl (University of Freiburg (DE))

Session Classification: PLENARY

Contribution ID: **193** Type: **not specified**

Parton Density Functions

Monday 24 March 2025 11:00 (30 minutes)

Presenter: UBIALI, Maria (University of Cambridge (GB))

Session Classification: PLENARY

Contribution ID: **194** Type: **not specified**

QCD simulations / MC

Monday 24 March 2025 14:30 (30 minutes)

Presenter: VAN BEEKVELD, Melissa Corona (Nikhef National institute for subatomic physics (NL))

Session Classification: PLENARY

Contribution ID: **195** Type: **not specified**

EIC / ePIC status

Monday 24 March 2025 16:00 (30 minutes)

Presenter: DALLA TORRE, Silvia (Universita e INFN Trieste (IT))

Session Classification: PLENARY

Contribution ID: **196** Type: **not specified**

Spin / 3D structure theory

Monday 24 March 2025 16:30 (30 minutes)

Presenter: Prof. PASQUINI, Barbara (University of Pavia and INFN-Pavia)

Session Classification: PLENARY

Contribution ID: **197** Type: **not specified**

Jets and hadronic final states

Monday 24 March 2025 14:00 (30 minutes)

Presenters: HOLGUIN, Jack; HOLQUIN, Jack

Session Classification: PLENARY

Contribution ID: **198** Type: **not specified**

Low x theory

Presenter: SIEVERT, Matthew (New Mexico State University)

Session Classification: PLENARY

Contribution ID: **199** Type: **not specified**

Precision QCD calculations

Monday 24 March 2025 15:00 (30 minutes)

Presenter: RONTSCH, Raoul Horst

Session Classification: PLENARY

Contribution ID: **200** Type: **not specified**

Diversity, Equity and Inclusion in Physics

Thursday 27 March 2025 11:00 (30 minutes)

Presenter: DAVID, Claire (AIMS South Africa)

Session Classification: PLENARY

Contribution ID: **201** Type: **not specified**

Diffraction / Forward Physics experiment

Thursday 27 March 2025 11:30 (30 minutes)

Presenter: TU, Zhoudunming

Session Classification: PLENARY

Contribution ID: **202** Type: **not specified**

Ultraperipheral Collisions

Friday 28 March 2025 09:30 (30 minutes)

Presenter: STEINBERG, Peter Alan (Brookhaven National Laboratory (US))

Session Classification: PLENARY

Contribution ID: **203** Type: **not specified**

Concluding Talk

Friday 28 March 2025 16:30 (45 minutes)

Presenters: LEVY, Aharon (Tel Aviv University (IL)); NEWMAN, Paul Richard (University of Birmingham (GB))

Session Classification: PLENARY

Contribution ID: **204** Type: **not specified**

Lattice QCD

Monday 24 March 2025 11:30 (30 minutes)

Presenter: DEL DEBBIO, Luigi (The University of Edinburgh (GB))

Session Classification: PLENARY

Contribution ID: **205** Type: **not specified**

Nuclear PDFs

Monday 24 March 2025 12:00 (30 minutes)

Presenter: NOCERA, Emanuele R. (The University of Edinburgh)

Session Classification: PLENARY

Contribution ID: **206** Type: **not specified**

Spin / 3D structure Experiment

Friday 28 March 2025 09:00 (30 minutes)

Presenter: KEPPEL, Cynthia (Thia)

Session Classification: PLENARY

Contribution ID: **207** Type: **not specified**

Higgs/BSM at (HL)-LHC

Thursday 27 March 2025 12:00 (30 minutes)

Author: MARCHESE, Luigi (ETH Zurich (CH))

Presenter: MARCHESE, Luigi (ETH Zurich (CH))

Session Classification: PLENARY

Contribution ID: **208** Type: **not specified**

Future Opportunities with Lepton-Hadron Collisions (Input to EPPSU)'

Friday 28 March 2025 11:00 (30 minutes)

Presenter: NEWMAN, Paul Richard (University of Birmingham (GB))

Session Classification: PLENARY

Contribution ID: **209** Type: **not specified**

WG1 Summary

Friday 28 March 2025 11:30 (30 minutes)

Presenter: HOBBS, TIMOTHY J (Argonne National Laboratory)

Session Classification: PLENARY

Contribution ID: **210** Type: **not specified**

WG2 Summary

Friday 28 March 2025 12:00 (30 minutes)

Presenters: WEIGERT, Heribert (Universtiy of Cape Town); KUTAK, Krzysztof (Instytut Fizyki Jadrowej Polskiej Akademii Nauk); CLAWSON, Savannah (Deutsches Elektronen-Synchrotron (DE))

Session Classification: PLENARY

Contribution ID: **211** Type: **not specified**

WG3 summary

Friday 28 March 2025 14:00 (30 minutes)

Author: DOBUR, Didar (Ghent University (BE))

Presenter: DOBUR, Didar (Ghent University (BE))

Session Classification: PLENARY

Contribution ID: **212** Type: **not specified**

WG4 Summary

Friday 28 March 2025 14:30 (30 minutes)

Presenters: PAGE, Brian; SIGNORILE , Chiara

Session Classification: PLENARY

Contribution ID: **213** Type: **not specified**

WG5 Summary

Friday 28 March 2025 15:00 (30 minutes)

Presenter: LI, Wenliang (Mississippi State University (US))

Session Classification: PLENARY

Contribution ID: **214** Type: **not specified**

WG6 Summary

Friday 28 March 2025 15:30 (30 minutes)

Presenters: BOYD, Jamie (CERN); FORTHOMME, Laurent (AGH University of Krakow (PL))

Session Classification: PLENARY

Contribution ID: **215** Type: **not specified**

kT factorization approach and j/psi production at Electron Ion collider

Wednesday 26 March 2025 11:40 (20 minutes)

Presenter: RAWOOT, Vaibhav

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **218** Type: **not specified**

Entanglement entropy, Krylov compexity and Deep Inetastic Scattering

Tuesday 25 March 2025 11:40 (20 minutes)

Presenter: KUTAK, Krzysztof Marek (Polish Academy of Sciences (PL))

Session Classification: WG2: Small-x, Diffraction and Vector Mesons

Contribution ID: **219** Type: **not specified**

Diffraction in Sherpa

Tuesday 25 March 2025 09:40 (20 minutes)

Presenter: KRAUSS, Frank

Session Classification: WG2: Small-x, Diffraction and Vector Mesons